

A REINTERPRETATION OF THE DEVELOPMENT
OF THE OBJECT CONCEPT IN INFANCY

by

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I hereby certify that the work reported in this thesis
is my own.

Irene E. Neilson

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SUMMARY

Although Piaget originally described the Object Concept as developing over six stages, in recent years the development of the Object Concept appears to have become synonymous with the eight month old infant's failure to search appropriately for an object hidden under one of two cloths in the Stage IV - V transition test. Much theoretical controversy centres on whether this failure reflects the infant's inability to represent objects that are no longer visible, his egocentric notions of space, or limitations of his motor, memory and information processing skills.

This thesis argues that none of the above explanations are adequate. All are seen to suffer from a lack of consideration of what is known about the infant's competence at earlier stages in the developmental sequence. The pre-8 month old infant can conserve the existence of an object in other task contexts. Further practice at earlier stages of the development of the Object Concept beneficially affects the infant's performance in the Stage IV - V task suggesting that an explanation of the infant's difficulties in the latter task must relate to an explanation of all the stages in the developmental sequence.

This thesis attempts to give such an explanation, an overall framework in which the interrelation of stages in the development of the Object Concept can be seen. It is called "The identity hypothesis."

This hypothesis suggests that development through Stages I - III of the Object Concept is development of rules of object identity - rules that specify the sameness, the uniqueness of an object through the various transformations it may undergo. These rules are seen to constrain the set of spatial relations that may exist between objects.

At around eight months of age, it is argued that the infant's concept of object identity is such that if an object shares a spatial boundary with another its individual identity is lost. Thus the spatial relationships 'inside' 'under' and 'on', are argued to be incomprehensible to the infant. But, the former two relationships are involved in the Stage III - VI transition tasks. Thus it is argued that the infant's difficulties in these tasks stem not so much from the disappearance of the object per se, but from the type of spatial relationship pertaining between the object and the occluder. This thesis offers support for this analysis by demonstrating that even if the object is not hidden from view, but rather placed inside a transparent container or on a platform in full view of the infant the nevertheless makes the characteristic Stage IV - V and V - VI transition errors. However this model of the development of the Object Concept runs into several difficulties. Contrary to prediction, the infant is observed to have difficulty on the Stage III - V transition tasks even if the object is hidden behind a screen, although such a spatial relationship does not generally involve the sharing of object boundaries. An attempt is made to incorporate this finding within the identity hypothesis by postulating that when the distance between the object and screen is small the infant does not see them as perceptibly separate from each other but rather as sharing a common boundary.

CHAPTER I

1.1. The importance of the Object Concept

The development of the Object Concept (Piaget 1937) is argued to be the child's most significant intellectual achievement during the first two years of life. According to Piaget this segment of development is the prototype of cognitive development in general and forms the basis from which logical thought and mathematical reasoning develop.

Bell (1970) and Schaffer and Emerson (1964) share Piaget's enthusiasm. Both view the development of the Object Concept as being of crucial importance for the social development of the child. Differentiated, affective attachments to specific human beings are argued to occur at the same time as the infant begins to search in earnest for a vanished object. Both behaviour patterns are thus viewed as a function of the growth of the infant's ability to represent objects - his development of an Object Concept. Social behaviours such as stranger fear and separation anxiety are thus explained by the growth of the Object Concept. To be scared of a stranger is to be able to note the discrepancy between the features of the stranger and the features of a developed internal representation of one's mother.

Psycholinguists such as Roberts and Black (1972), Brown (1973), Bloom (1973), Edwards (1973) have also argued that the infant's development of an Object Concept is of great importance. The possession of an Object Concept is viewed as being a necessary precursor to language development. Roberts and Black (1972) and Brown (1973) argue that the young child would be unable to grasp the referential function of language unless he had the concept of a stable and enduring object. Edwards (1973) argues for a close correspondance between the relational

meanings that are expressed universally in the two-word speech of the two year old child and the nature of sensori-motor intelligence. The development of the Object Concept thus provides

"the structures of knowledge and meaning via which language refers to the world. The acquisition of meanings is characterised as a process in which the meanings of input speech are assimilated to the child's perception of the world and events referred to." (P.398. COGNITION 1973 2/4).

The final accolade for the importance of the Object Concept comes from Elkind and Sameroff (1970) who regard it as Piaget's most significant discovery.

It is thus with some trepidation that I wish to propose in this thesis that the problem of the development of the Object Concept has been largely misconstrued.

1.2. THE TRADITIONAL PRESENTATION OF THE PROBLEM

As it is traditionally presented, the development of the Object Concept is regarded as the development of the child's ability to represent objects which are no longer visible.

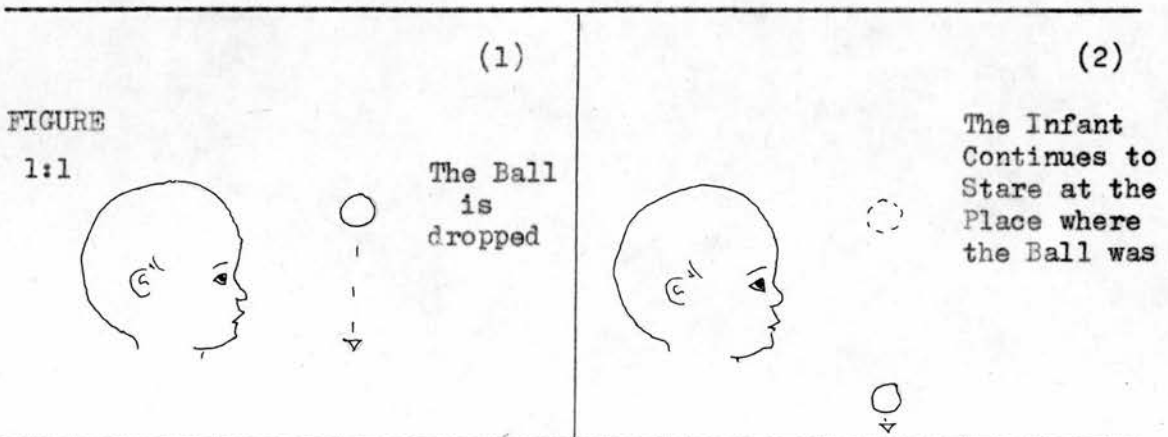
Piaget himself argues that the problem is more complicated than that:-

"... from the onset .. the formation of the scheme of the permanent object is closely related to the whole spatial - temporal and causal organization of the practical universe." (CONSTRUCTION OF REALITY 1937).

This narrow interpretation of what the development of the object concept involves can be seen to be the result of the manner in which Piaget investigated the child's concept of an object. Piaget basically took the child's reaction to the disappearance of an object as indicative of his understanding of objects. Piaget's experimental strategy thus bears a strong resemblance to the use of the delayed - response tasks (CARR-HUNTER 1913), by comparative psychologists in their investigations of whether animals were capable of 'representing' events.

1.3. PIAGET'S DESCRIPTION OF THE DEVELOPMENTAL SEQUENCE

According to Piaget the development of the Object Concept occurs in Six Stages. These stages are distinguished and classified by changes in the child's reaction to objects that have disappeared from his visual field. At Stage I-II (0-2 months), Piaget argues that the infant shows no particular behavioural response to vanished objects. If for example, an object is held in front of the infant and then dropped the infant will not track its displacement but will remain fixated at the point where he had last seen the object (FIGURE 1: 1).

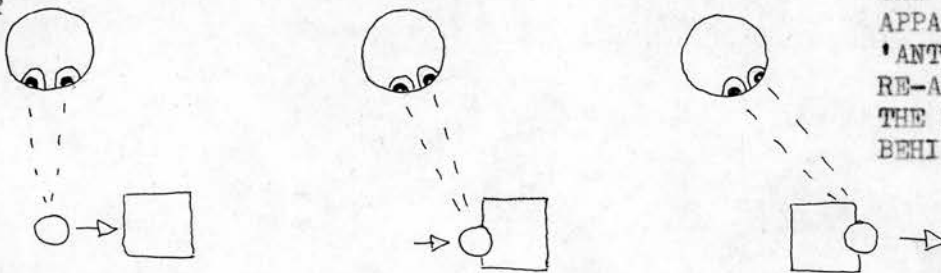


At Stage II-III (2-4 months) the infant will follow the trajectory of a displaced object. For example, he will track his mother across the room and will continue to track even if she disappears from sight through a door-way.

"In the realm of sight, Jacqueline, as early as 0:2 follows her mother with her eyes, and when her mother leaves the visual field, continues to look in the same direction until the picture re-appears." (P.9. CONSTRUCTION OF REALITY).

Piaget however argues that such a behaviour pattern does not demonstrate true permanence but merely reflects accommodatory adjustments of the infant's sense organs. The infant rather than tracking an object that has disappeared from sight is argued to be simply "pursuing the trajectory delineated by the immediately preceding perception" (Piaget 1954). Evidence for this statement is obtained from the fact that a child of this age will continue to track a previously moving object when it has become stationary (FIGURES 1:2 & 1:3).

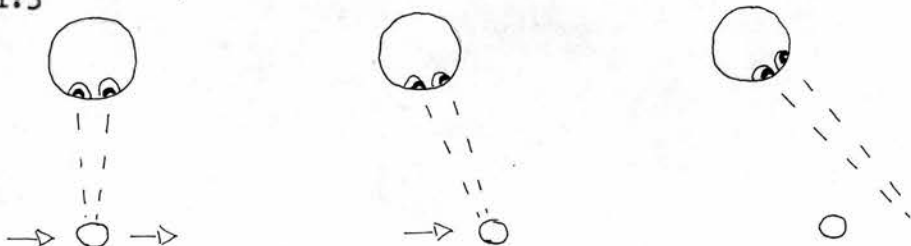
FIGURE
1:2



THE INFANT
APPARENTLY
'ANTICIPATES' THE
RE-APPEARANCE OF
THE BALL FROM
BEHIND THE SCREEN

BUT.

FIGURE
1:3



() THE INFANT CONTINUES TO "TRACK THE BALL" ALTHOUGH IT IS NOW STATIONARY.

At Stage III-IV (4-6 months) the infant according to Piaget demonstrates in his behaviour the beginning of true permanence. He will now track the displacement of an object that is dropped in front of him.

"At 0:6 he (Laurent), holds an empty match box in his hand. When it falls his eyes search for it, even if they have not followed the beginning of the fall; he turns his head in order to see it on the sheet."
(P.15. CONSTRUCTION OF REALITY).

The infant will also now stop tracking an object when it itself stops moving. The beginnings of permanence are also seen in the infant's reaching behaviour. At this age the infant will reach for an object that has been partially covered (FIGURE 1:4). If however the object is totally covered the infant will not make any attempt to uncover the object (FIGURE 1:5). He acts as if the object no longer exists. Neither tactile (Gratch 1971) nor auditory input (Piaget 1937, Moore 1969) appear initially capable of compensating for the lack of visual information as to the object's whereabouts (FIGURE 1:5b)

FIGURE
1:4



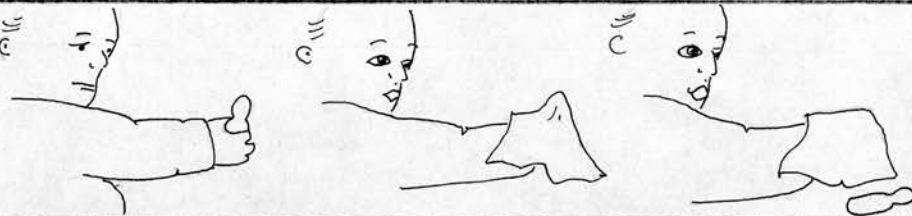
THE INFANT WILL REACH FOR AN OBJECT HALF-HIDDEN BY A CLOTH

FIGURE
1:5a



THE INFANT WILL NOT REACH FOR AN OBJECT WHICH IS TOTALLY HIDDEN BY A CLOTH OR CUP

FIGURE
1:5b



THE
OBJECT
IS
DROPPED

EVEN IF THE INFANT IS HOLDING THE OBJECT IN HIS OWN HAND WHEN IT IS COVERED HE WILL STILL NOT REMOVE THE CLOTH FOR THE OBJECT.

When the infant can recover the object from under the cloth the third stage ends. At Stage IV-V (6-12 months) the infant appears to have a peculiar concept of an object. The infant will look for an object if it is hidden under a cloth in position A. However, having found the object under the cloth at position A, the infant will continue to look for the object under that cloth even when the object is moved to an alternative location B and covered by another cloth (FIGURE 1:6).

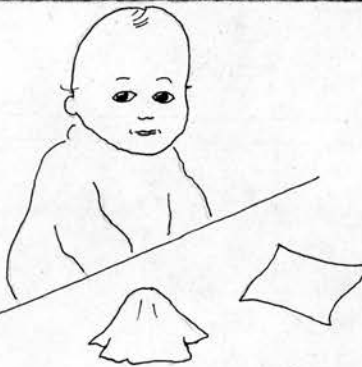
"Jacqueline is seated on a mattress without anything to disturb or distract her. I take the parrot from her hands and hide it twice in succession under the mattress on her left, in A. Both times Jacqueline looks for the object and grasps it. Then I take it from her hands and move it very slowly before her eyes to the corresponding place on her right, under the mattress, in B. Jacqueline watches this movement very attentively but at the moment when the parrot disappears in B she turns to her left and looks where it was before, in A." (P.51. CONSTRUCTION OF REALITY)

This error implies that the infant does not yet really understand that an object that has been covered by a cloth is under that cloth.

According to Piaget:

"Such behaviour patterns seem to show us that the object is not yet, at this stage, a substantial thing remaining in the place to which it was moved but a thing at disposal in the place where the action made use of it. active search for the vanished object is not immediately general but is governed by a restrictive condition: the child looks for and conceives of the object only in a special position, the first place in which it was hidden and found." (P.50. CONSTRUCTION OF REALITY)

FIGURE
1:6



THE INFANT
REMOVES CLOTH
A FOR THE
OBJECT



THE INFANT
REMOVES CLOTH
A FOR THE
OBJECT



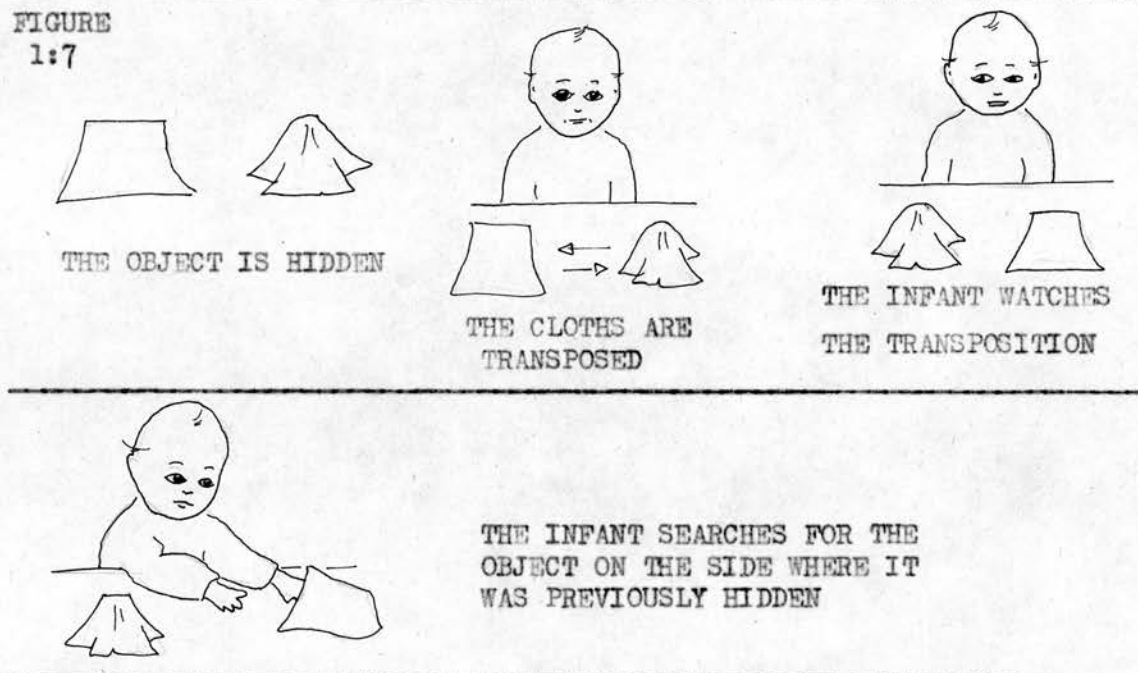
DESPITE HAVING
WATCHED THE
OBJECT HIDDEN
UNDER CLOTH B
THE INFANT
LOOKS FOR IT
UNDER CLOTH A.



When the infant can cope with the Stage IV-V transition task he enters Stage V. (12-18 months). He has proved himself to be capable of

dealing with visible displacements of the object. His behaviour in Stage V, however, is characterised by the fact that he cannot cope with invisible displacements of the object. Take for example the Stage V-VI transition task designed, independently by Aronson (1971) and McGonigle (1971) the object is hidden under one of two opaque cloths. The cloths are then transposed. The infant characteristically will track the movement of the cloth + object but will look for the object underneath the cloth on the side where the object was first placed. (FIGURE 1:7).

FIGURE
1:7



Piaget himself uses a more complicated task,¹ to assess the infant's ability to cope with invisible displacements. This task format is illustrated in Figure 1:8. Even if the child can successfully solve the above test format, Piaget argues that this does not provide sufficient evidence that he understands the invisible displacement of

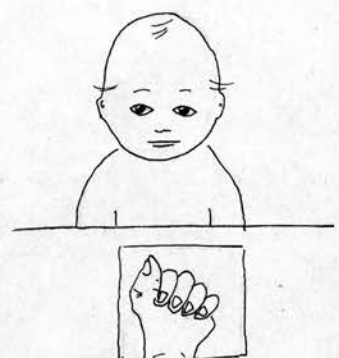
1. This task has been shown by Moore (1969), using a Guttman Scale Analysis, to be more difficult for the infant than the Stage V-VI transposition task designed by Aronson and McGonigle.

FIGURE
1:8

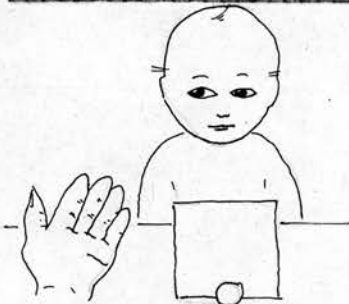
THE OBJECT IS PLACED IN
THE EXPERIMENTER'S HAND



THE HAND IS
CLOSED



IT IS THEN MOVED
BEHIND THE SCREEN
THE INFANT TRACKS



THE HAND RE-EMERGES
THE OBJECT IS RELEASED
BEHIND THE SCREEN



THE INFANT
SEARCHES IN THE HAND



HE IS UNABLE TO INFER
WHERE THE OBJECT HAS GONE

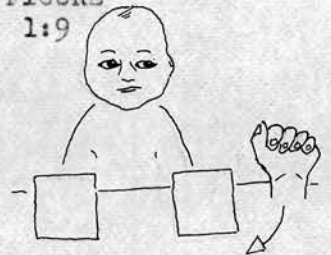
the object. He is successful only by 'empirical groping.' Piaget's evidence for this statement is derived from the following observation:

"I place the object in my hand, put my hand under A and bring it out closed. Jacqueline searches in my hand, looks at it, over and over, then looks at me with astonishment, examines the floor and as though enlightened by her thoughts turns over the garment A. She takes the object and laughs.

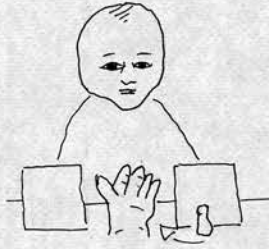
I repeat the same gestures in B. Jacqueline opens my hand, again hesitates for a moment and then returns to A without hesitation the reaction is very definite with an attitude of sustained attention." (P.75. CONSTRUCTION OF REALITY) (FIGURE 1:9)

Only when the infant can solve this task is Piaget willing to concede that he has a fully fledged behavioural understanding of the Object Concept.

FIGURE
1:9



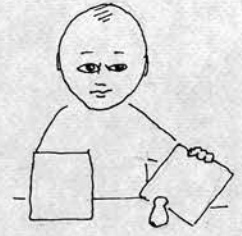
The object is hidden
in the hand



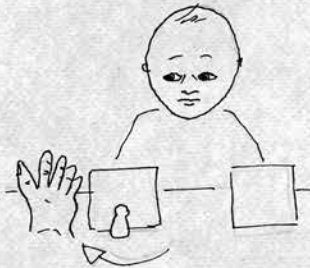
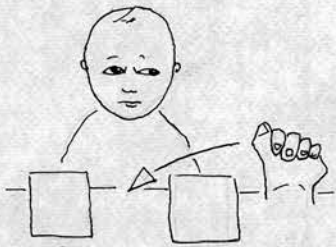
The hand moves
behind the screen.
The infant tracks



He searches
in the hand
as it is
not there ..



He looks
behind the
screen for
the object



When the object is then left behind the other screen although the
infant tracks its displacement he looks behind the first screen
for it.

1.5. VALIDATION OF PIAGET'S DESCRIPTION

Piaget's basic description of the development of the Object Concept from birth to eighteen months of age has been confirmed by Gouin-Décarie (1965), Escalona and Corman (1969), Uzgiris and Hunt (1966) and in broad outline by Miller and Cohen (1970). Woodward (1965) has confirmed that the hierarchy of task difficulty contained in Piaget's stage description does exist in retarded children. Gouin-Décarie (1969) has also confirmed the formal similarity of the errors the infant makes during behavioural development of the Object Concept to those made in dealing with words that represent objects.

Comparative studies of the development of the Object Concept in animals have also been carried out. Gruber, Girgus and Banuazzi (1971) observed a similar sequence of development in kittens although the sequence was completed by 20/24 weeks of age, culminating in less complex behaviour patterns. Vaughter, Smotherman and Ordy (1972) observed a similar developmental sequence in squirrel monkeys as did Wise, Wise and Zimmermann with rhesus monkeys - the latter investigators concluded:

"In each testing situation was found a sequence of development of object permanence that was very similar to the one described by Piaget for the child and in each case the sequence culminated in behaviours nearly as complex as those described by Piaget for the two year old child."

1.6. THEORETICAL CONTROVERSY SURROUNDING THE DEVELOPMENT OF THE OBJECT CONCEPT

The accuracy of Piaget's description of the behaviour patterns characterising the development of the Object Concept is thus not in

doubt. Theoretical controversy largely centres on his explanation of the problem facing the infant at Stage III of the developmental sequence and why the infant makes the particular type of error that he does in the Stage IV-V transition tasks.

Little attention has been paid to the evaluation of Piaget's stage model of development,² and even less to his theorising on the relationship of the development of the Object Concept on the behavioural plane to early language development.

(1971)

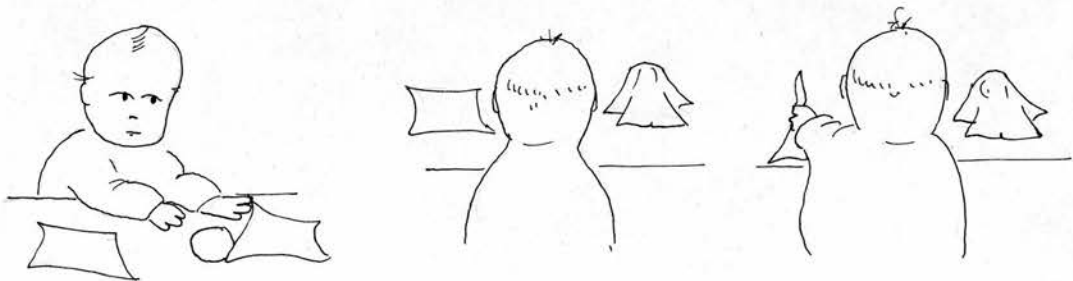
Gratch/and Schaffer (1971) agree with Piaget that conservation of an object that is no longer visible is the main problem facing the infant in the Stage III task. Given that neither auditory (Fraiberg, Siegel & Gibson 1966, Freedman, Fox-Kolenda, Margileth & Miller 1969 and Piaget 1954) nor tactile (Gratch & Landers 1971, Gratch 1972) information appears initially capable of substituting for the lack of visual information as to the object's whereabouts when hidden by a cloth, Gratch and Schaffer further agree that the development of inter-sensory co-ordination plays an important part in the growth of the infant's ability to represent an object that is no longer visible.

Evans and Gratch (1972) have taken issue with Piaget over his explanation of why the infant makes the Stage IV-V transition error. Piaget argues that having found the object twice at A, the infant on the B trial of the AAB sequence searches for the object at A because

-
2. The only theorists who have attempted to provide evidence for Piaget's stage model of development during the sensori-motor period are Bower (1974)^A and Gratch and Landers (1971). Both noted that the probability of error in the Stage IV-V transition task remained at 0.5 until the infant could cope with the task, an observation that is congruent with Piaget's stage model.

he identifies the object in terms of his last successful action to that location. Evans and Gratch (1972) argued that, if that was the case, if a different object was hidden at B the infant would not search at A. They observed that this was not the case and concluded that A is a sort of 'toy box' to the infant. Infants thus were argued to err in the Stage IV-V task because of place-responding habits. Moore (1969) supported this analysis.

Landers (1971) and Bremner and Bryant (1976) likewise focussed their attention on the Stage IV-V transition error. These theorists argued that their results demonstrated that the infant made the Stage IV-V transition error because of response preservation rather than place responding habits. Landers observed that if infants were not given active search experience of finding the object at A they made fewer runs of errors in subsequent B trials. Gratch (1976) however pointed out that those infants who did not have active search experience of finding the object at A nevertheless made as many errors in the 1st subsequent B trial as did infants who had. Evans and Gratch (1972) and Evans (1973) were also unable to confirm, by replication, Landers' original findings. Bremner and Bryant observed that if the object was hidden at A twice and the infant then moved to the other side of the testing table (FIGURE 1:11)



the infant would search in B for the object when it was again hidden at A. They thus concluded that their results "support the notion that preservation (in the AAB test) is of responses rather than places." Bremner and Bryant's conclusion is however invalid. Their experiment fails totally to distinguish between place in the sense of geographical position and place coded relative to the self i.e. 'to the left or right of me.' The infants could have searched in B because it was the place to the left of them. No resolution of the 'place' v 'response' preservation argument has thus yet been made. It is interesting to observe that this controversy has long been a central problem in comparative psychology (see Gleitman 1969). Few developmental investigations of this problem match the sophistication of the latter studies however.

Paralleling the fact that the delayed response task used by comparative psychologists developed into a test of an animal's memory capacity rather than of his capacity for ideation, so too developmental psychologists have argued that the Stage III Object Concept task is really a test of the infant's memory capacity rather than his ability to represent an object that is no longer visible. According to Harris (1973) the infant fails the Stage III task because of a primary memory difficulty and makes the Stage IV-V error because of pro-active interference. A similar argument is made by Webb, Nadolny and Massar (1972) who argue that the infant makes the Stage IV-V error because of a conflict between visual memory of a recent event and action based memory for a successful action. Both these approaches assume that the fact that the object is

no longer visible to the infant in the Stage III and IV-V task is important. On a different tack, altogether, Yonas (Bower 1974)^A has argued that the infant fails the Stage III task simply because he lacks the appropriate motor skill to remove the cup for the object. Bower and Wishart (1972)^A demolished this suggestion by showing that infants who failed the Stage III task could nevertheless remove a transparent cloth in order to obtain the object from underneath. They observed however that even if the object was visible underneath the cloth it took the infant a considerable length of time to remove the cloth for the object. Bower and Wishart then suggested that the problem facing the infant in the Stage III task was a memory + motor skill problem. All of the above formulations³ make the assumption, like Piaget, that nothing very significant is happening in the infant's development prior to six months of life. It could be argued that this assumption is valid as Piaget writes that in Stage I-II of the development of the Object Concept the infant shows no particular behaviour towards vanished objects. Unfortunately, however, Piaget paid little attention to the need for careful psychophysical control of disappearance sequences. He presumed that a disappearance was a disappearance and neglected the point that different types of disappearance sequences involved different types of optical information. He likewise ignored other variables such as the speed at which the object was made to disappear. Perhaps however such factors are unimportant, perhaps they do not constrain the infant's behaviour in any way. Recent research indicates that such factors are important.

If the infant up until the end of Stage III simply believed that

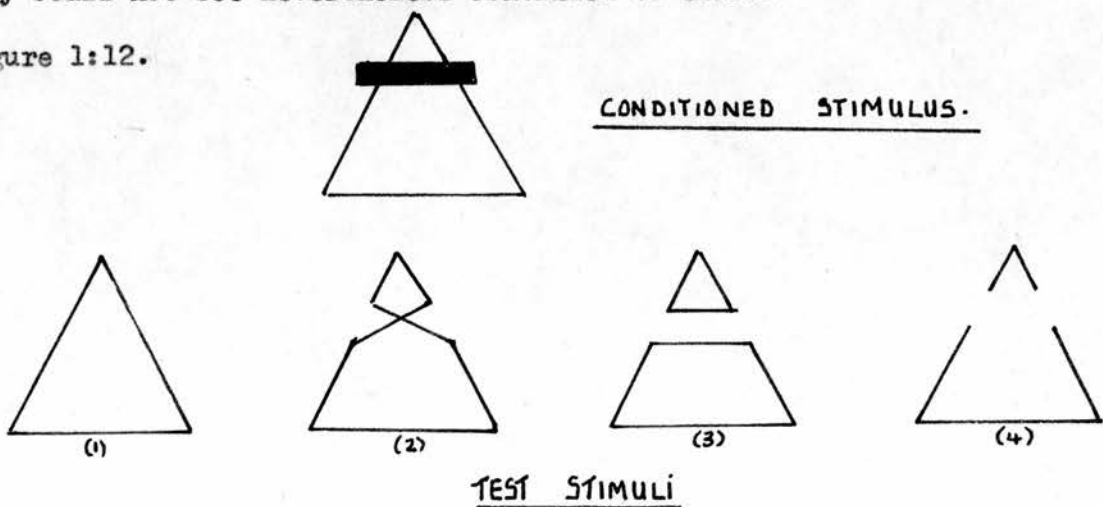
3. Except Bower and Wishart's work viewed in a historical light.

objects ceased to exist when they disappeared from sight then it would not matter what type of response an investigator used to assess their belief. Non permanence behaviour would be obtained regardless of whether heart-rate, eye movements, operant responses, or reaching behaviour were used. Bower (1967) however has observed that infants as young as 7 weeks of age appeared to expect an object to continue to exist if occluded by a screen if their heart-rate or operant sucking responses were observed. Further this demonstration of permanence behaviour was dependent on

- a) the rate at which the object was occluded
- b) the time during which the object is occluded.

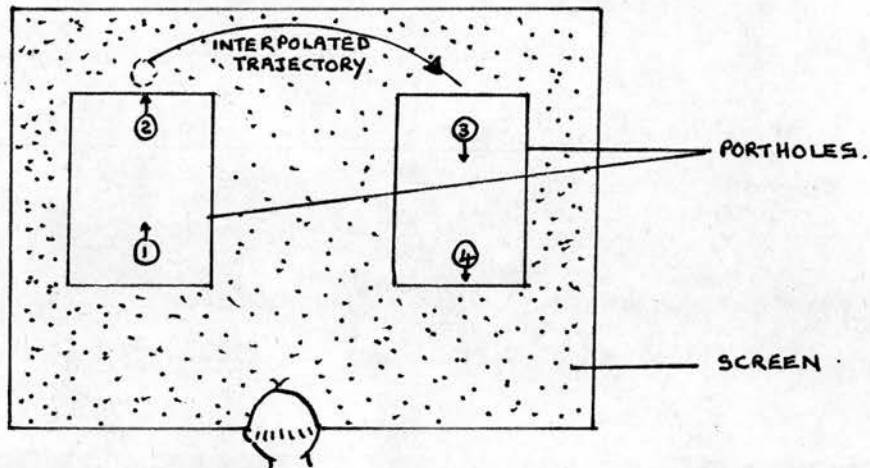
Likewise Bower (1967) demonstrated that infants as young as 6 weeks of age appeared to work with the Gestalt rule of good continuation. In this study the infants were conditioned to respond to a black wire triangle with a bar over it. They were then presented with four different wire triangles (Figure 1:12). All the infants were observed to make the greatest number of conditioned responses to the first of the four triangles. Such a result can be taken as evidence that the infants perceived the original display as a triangle with a bar over it. In other words they understood that the parts of the triangle they could not see nevertheless continued to exist.

Figure 1:12.



Further Bower, Broughton and Moore (1971) demonstrated that infants as young as 4 months of age can represent the path of objects that have disappeared behind a screen, even when the path must be inferred and cannot be tracked by continuing an ongoing movement. Mundy - Castle and Anglin (1969) have confirmed this observation. They used the experimental set-up demonstrated in Figure 1:13.

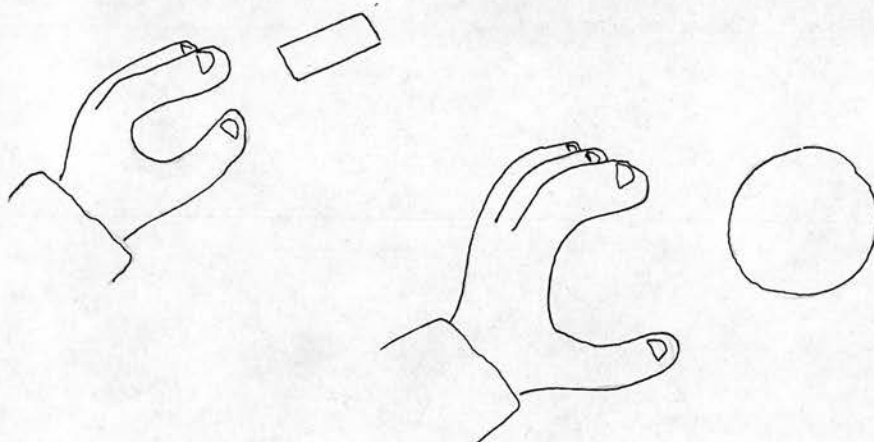
Figure 1:13



The infant observed an object appear in the left-hand porthole, travel up the porthole to disappear then reappear at position (3) and travel down to disappear again. Infants of 16 weeks of age were observed to interpolate a curvilinear trajectory between object position (2) and object position (3). The height of this trajectory was proportional to the difference between time of disappearance and time of reappearance of the object. The infants thus seemed capable of inferring the path the object must have taken to move from position (2) to position (3) within a given time interval of X seconds. Further if the grasping behaviour of a 4 to 5 month old infant is observed it is seen that the infant manifests representation of invisible surfaces. As Bower (1976) writes

"Differential hand shaping is quite well developed in such infants, and would not be possible without some mechanism for inferring information about the invisible side of an object." (P.42. in 'INFANT PERCEPTION: From Sensation to Cognition.' Cohen & Salapatek). (Figure 1:14)

Figure 1:14.



The infant thus prior to 6 months of age demonstrates a considerable degree of competence in dealing with disappearance sequences.

Let us now consider the arguments of Gratch and Schaffer that the development of inter-sensory co-ordination is an important factor in the development of the Object Concept. The assumption here is that the infant prior to 6 months of age lacks such a co-ordination of his senses. This assumption is invalidated by the work of several researchers who have demonstrated auditory - visual co-ordination at birth (Wertheimer 1961, Aronson & Rosenbloom 1971), visual-tactile co-ordination at 7 weeks of age (Bower, Broughton & Moore 1970)^A and auditory-manual co-ordination by at least 16 weeks of age (Bower & Wishart) (unpublished manuscript). The infants in the latter study were observed to be totally unable to remove a cloth to obtain an audible object from underneath despite being able to reach for an audible object in the dark. Further all the above co-ordinations

are observed to decline as the infant gains in his competence in dealing with the Object Concept tasks (Bower 1974).^B

Lack of inter-sensory co-ordination does not thus appear a satisfactory explanation of the six month old infant's failure in the Stage III task. Is the memory explanation offered by Harris any better? Bower (1974)^A argues no. To quote

'This hypothesis is attractively simple; however common observation - rather than systematic experimentation - would suggest that it is probably wrong. The memory span of the 5 to 6 month old infant is much greater than five minutes. Infants brought into the laboratory at this age often reveal that they remember what happened on a previous visit a day or more ago Infants who have previously been fooled in the virtual - object situation will not reach again for virtual objects in this situation.'
(P.205: DEVELOPMENT IN INFANCY 1974)^A

Secondly Harris' statement of the memory difficulty that the infant experiences in the Stage III task presumes memory to be a black box, a process or product separable from the perceptual and cognitive abilities of the organism. Recent research by Corsini 1971, Flavell 1971, Jenkins 1971, Sykes 1976, indicates that memory is not such a black box. Rather, what the organism can recall reflects the developmental state of his perceptual and cognitive capabilities (Massaro 1970, Craik & Lockhart 1972).

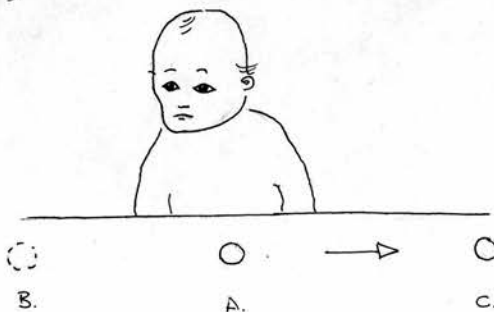
1.7. A QUESTION OF REPETITION IN DEVELOPMENT

In an attempt to reconcile the competence shown by the pre-6 month old infant with the incompetence demonstrated in the Stage III-IV, IV-V Object Concept tasks (6 to 12 months of age) the notion of

repetition in development has been evoked.

Schaffer (1971) has pointed out that the infant's understanding of the disappearance of an object has generally been assessed by using eye movements prior to 6 months of age (Bower, Broughton and Moore 1971, Mundy-Castle and Anglin 1969). After 6 months of age in the Stage III-IV, IV-V, Object Concept tasks the infant's understanding is assessed by using reaching behaviour. Accordingly, Schaffer appears to suggest that the infant has a "schizoid" mind in which information available to control eye movements is not available to control reaching behaviour at six months of age. This argument is plausible in so far as the errors the infant makes in tracking the disappearance of an object prior to six months of age are formally very similar to the errors he makes in the Stage IV-V transition task at nine months of age. As Piaget reports, prior to 6 months of age (Stage II-III) the infant will look for an object where it was last seen ignoring its current displacements. Bower, Broughton and Moore (1971) have also observed such behaviour. After several trials of watching an object move from A to B (Figure 1:15) the infant would, when the object moved to C, look for it at B.

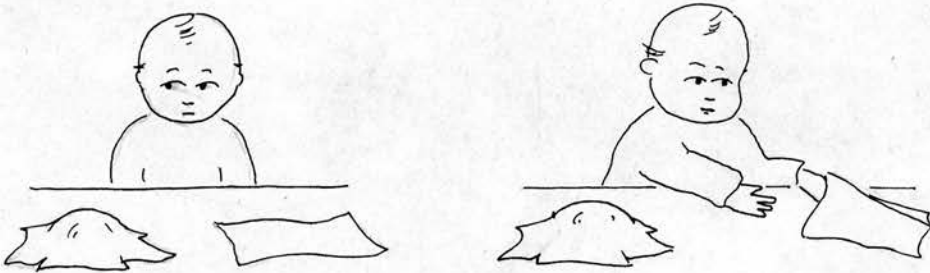
FIGURE
1:15



After several trials of observing the object move from A to B the infant is given a trial in which the object moves to C. He responds to this A-C displacement by looking for the object where it was last seen at B.

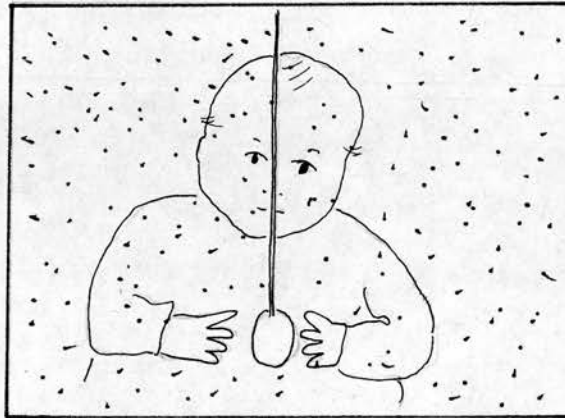
At 9 months of age in the Stage IV-V transition task the infant will search for the object in the place where it was last found ignoring its current displacement (FIGURE 1:16)

FIGURE
1:16



Two findings question Schaffer's argument. Bower and Wishart (1972)^A observed that infants who fail the standard Stage III Object Concept task would nevertheless reach for an object in the dark. The infants were placed in a lighted room and presented with an object dangling in free space. Before the infants were able to reach for the object the room was plunged into darkness. Despite the object now being out of sight all of the infants reached out and grabbed it (FIGURE 1:17). In their reaching behaviour all of the infants conserved the existence of the object when out of sight.

FIGURE
1:17



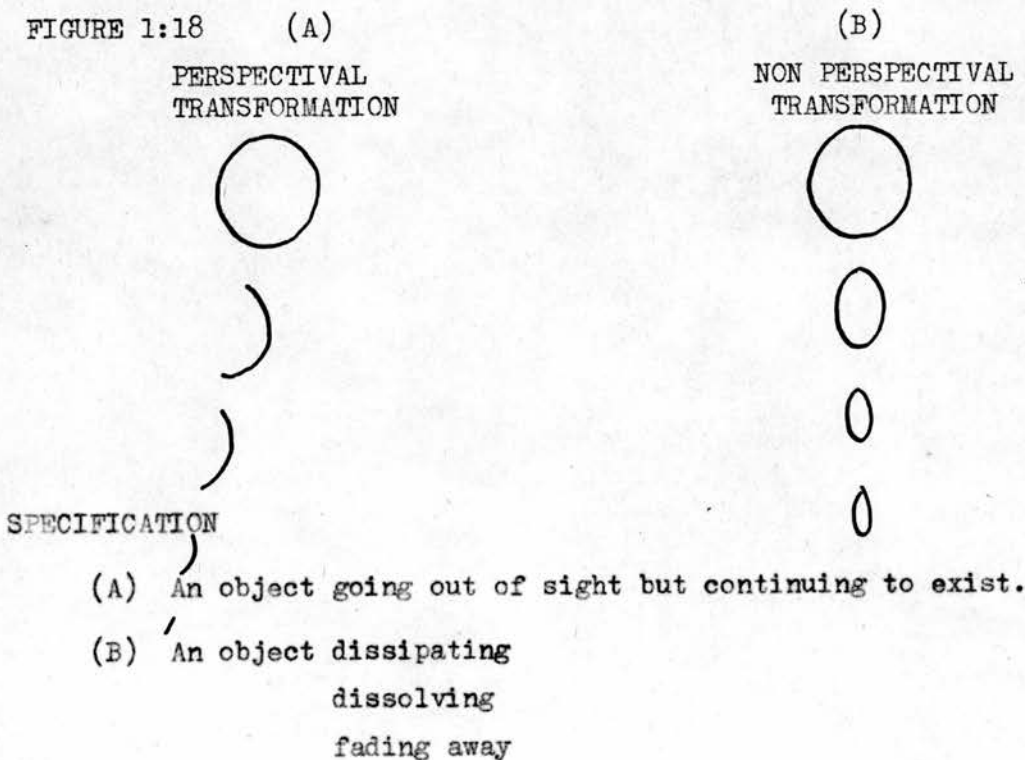
Secondly Bower and Paterson (1972) observed that training on tracking tasks prior to 6 months of age accelerated the rate at which infants passed through the Stage III-IV, IV-V Object Concept tasks. Such transfer of learning poses problems for Schaffer's repetition hypothesis. It is difficult to see what the basis of transfer could be between two motor systems as diverse as the hand and the eye.

This alternative explanation of the infant's failure in the Stage III-IV, IV-V Object Concept tasks would thus also appear to be unsatisfactory.

1.8. A POSSIBLE REFORMULATION OF WHAT THE PROBLEM IS: THE IDENTITY HYPOTHESIS

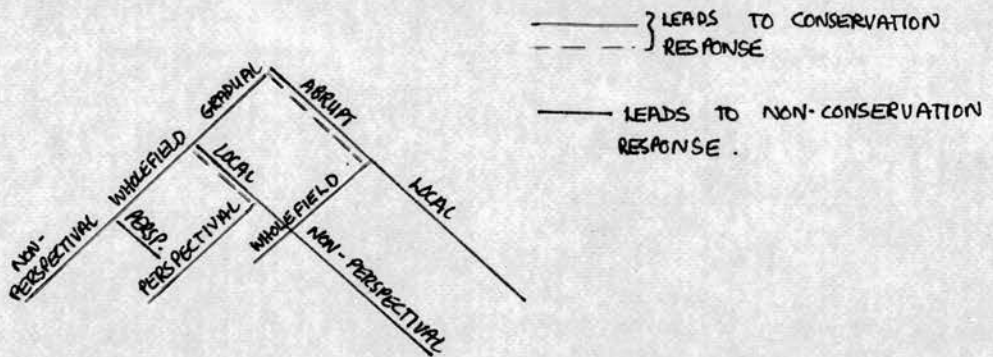
The question now becomes what explanation can be given of the six month old infant's failure to cope with the Stage III-IV, IV-V Object Concept tasks that is compatible with what we know about the infant's competence prior to six months of age? I believe that an explanation

can be given, or at least constructively sought, if investigators stop viewing the development of the object concept as involving primarily the growth of the infant's ability to conserve the existence of an object when it is out of sight. There is no such thing as a unitary concept of existence constancy. As Michotte (1962) has clearly demonstrated, the manner in which an object disappears from sight is of crucial importance in determining the adult's response. A transformation such as that described in Figure 1:18a is seen by the adult as specifying that the object is moving out of sight but continuing to exist. A transformation such as that described in FIGURE 1:18b is not seen by the adult as specifying the continued existence of an object rather it is seen as specifying that the object is fading away into oblivion.



Michotte has specified in some detail the stimulus conditions necessary for the adult to conserve the existence of an object that is no longer visible. His results are summarized in FIGURE 1:19. Only those stimulus conditions defined by the left hand branches of the tree lead to existence constancy.

FIGURE 1:19



The meaning of the dichotomies is fairly clear. An abrupt disappearance is one in which there are no detectable intermediaries between appearance and disappearance. Such is the case when an object explodes. A local non-perspectival transformation occurs when an object fades away, dissolves or dissipates. These disappearance sequences lead to non conservation of the existence of the object. By contrast whole field transformation and gradual local perspectival transformations lead to conservation responses. The former occurs when the lights of a room are switched off, the latter when a person leaves a room.

What then is the relevance of Michotte's work on existence constancy with adults for theorising on the development of the Object Concept in young infants? Through a consideration of Michotte's work Gibson et al (1969) have suggested that the development of the Object Concept does not involve the construction of the existence of an object

by conceptual processes but rather involves processes of perceptual differentiation whereby the infant learns to decipher one type of optical information specifying the continued existence of the object from another type which does not specify this. Bower (1967) has however questioned Gibson's theory. Bower replicated Michotte's work with very young infants, on average 3 weeks of age. He observed that

"there is remarkably little difference between infant and adult as far as psychophysical control (of response to disappearance sequences) is concerned." (Perception and Psychophysics 1967)

Infants, as indicated by their heart-rate, sucking and operant responses, all conserved the existence of an object in those situations where the optical information available corresponded to that indicated in the left hand branch of Michotte's tree diagram. The only difference between the infants in Bower's study and the adults in Michotte's study was in the rate at which the infant could process the optical information and in his ability to store such information in memory.

Such results would appear to suggest that there is no such thing as a development of an Object Concept. The changes in the infant's responses to disappearance sequences as described by Piaget could be argued to merely reflect changes in the infant's processing capacities. Certainly, if an object in Bower's study was moved behind the screen too quickly, this gradual local perspective transformation was changed into an abrupt transformation in the infant's eyes and led to a non conservation response. Likewise change in the infant's ability to track an object that is dropped in front of him could be argued to

reflect change in his rate of processing information. As Bower writes

"If one follows the development of the Object Concept in field situations, it is not obvious that anything is incrementing other than search skill, processing rate and trace duration."

Pascual-Leone⁴ makes a similar suggestion. He points out that each stage in the development of the Object Concept is characterised by an increase in the amount of information the infant has to handle (FIGURE 1:19b). The orderliness of the infant's progression through this developmental sequence is seen to reflect changes in the infant's processing capacity, motor skills and memory capacity. There is no conceptual development taking place. The infant is merely becoming better at mapping his competence in his performance.

<u>FIGURE 1:19b</u>	<u>Reaction to disappearance</u>	<u>Constraints on reaction</u>
Stage I-III	Perceptual Analysis (same competence as the adult)	(1) speed of occlusion (2) duration of occlusion
Stage III-IV	Perceptual Analysis	same as above but also (1) motor skill and (2) greater demand on memory capacities due to (1)
Stage IV-V	Perceptual Analysis	same as Stage III-IV but also now has to consider two containers in the visual field
Stage V-VI	Perceptual Analysis	same as Stage IV-V but also has to consider movement of the containers.

Such an analysis of the infant's behaviour in the Object Concept tests is supported by Butterworth (pers comm) in theory and by the work of

4. Personal Communication about his work from Dr. J.S. Watson, Stanford University.

Harris (1973) which demonstrated that how long the object was occluded for affected the infant's behaviour in the Stage IV - V task. Likewise the limited information processing capacities of infants during this developmental sequence has been demonstrated in studies outwith the framework of the Object Concept:-

Ahrens (1954) study of the smiling response

Bower (1966b) study of Heterogenous Summation

Salapatek (1966) study of pattern perception and

Bower and Dunkeld's (1973) study of the visual exploration of objects by infants.

However is this approach capable of accounting for all the evidence that has been gathered in respect of the development of the Object Concept? Certainly Pascual-Leone's model can in principle account for differences in the infant's reactions to disappearance sequences as indicated by his eye movements as opposed to his reaching behaviour as the latter task situations involve a greater demand on his information processing capacities.

However, while processing limitations are bound to play a part in the development of the Object Concept, they do not appear capable of totally explaining this development. Processing capacities, memory capacities and motor skill all change over time. The 12 month old infant's abilities in this respect are very different from that of the 6 month old. Both are as likely to make the Stage IV - V transition error. A theorist committed to a "processing capacity" model of the development of the Object Concept could explain this apparently anomalous fact by arguing that although the processing capacity of the 12 month old was greater than that of the 6 month old it still was not

sufficient to meet the demands of the Stage IV - V task. He would then however have difficulty in accounting for the results of Bower and Paterson's (1972) study in which practice at Stage II - III of the developmental sequence was shown to accelerate development through the latter stages of the Object Concept. While it is possible to suggest that such early experience increased the information processing capacities of the young infant, such a reply would be insufficient. It cannot deal with the selective nature of the type of Stage II - III experience that was required for acceleration. Practice in tracking tasks that did not involve the object stopping every so often, had no effect on Stage III - VI development. Such tasks could however be argued to equally exercise and extend the infant's processing capacities.

Secondly such an approach is incapable of explaining the fact that the infant's performance in the Stage II - III and IV - V transition tasks remains at chance until the infant succeeds for good (Bower and Paterson 1972, Gratch and Landers 1971). On a processing limitations model, performance in a given transition task would be expected to gradually stabilise over time as processing capacity and familiarity with the task increased.

Thirdly this approach neglects one other very important aspect of Michotte's work. Michotte demonstrated that it was not solely the available optical information about the object's transition to out of sight that determined the conservation response in the adult. The adult's response to the disappearance of an object was also

constrained by his appreciation of the type of object that was undergoing the transformation, by the way in which he identified the object. Anyone who has ever observed a conjurer at work can easily appreciate how knowledge about an object, description of its properties constrains one's response to its disappearance. Michotte's work therefore implies a close relation between the infant's ability to cope with a given disappearance sequence and the way in which he identifies an object.

This implication of Michotte's work I wish to argue holds the key to the understanding of what the development of the Object Concept is all about. It suggests a totally different way of viewing this developmental sequence.

Consider what we know of the way in which the infant identifies an object prior to 6 months of age. Bower (1974)^A has argued that the infant initially defines an object as a "bounded volume of space." The infant will not reach for objects if they are not defined parallaxically nor will he if the object does not have well specified fore and aft boundaries (Bower 1966)^A. Secondly the infant appears to identify an object in terms of its path of movement in space or its position. Although the infant can pick up featural information about

an object (Bower 1974)^A, he does not initially use that information in defining the latter. The 12 to 16 week old infant's definition of object identity would thus appear to be

Rule I. An object is a bounded volume of space in a particular location. As corollary the infant would appear to have the rule.

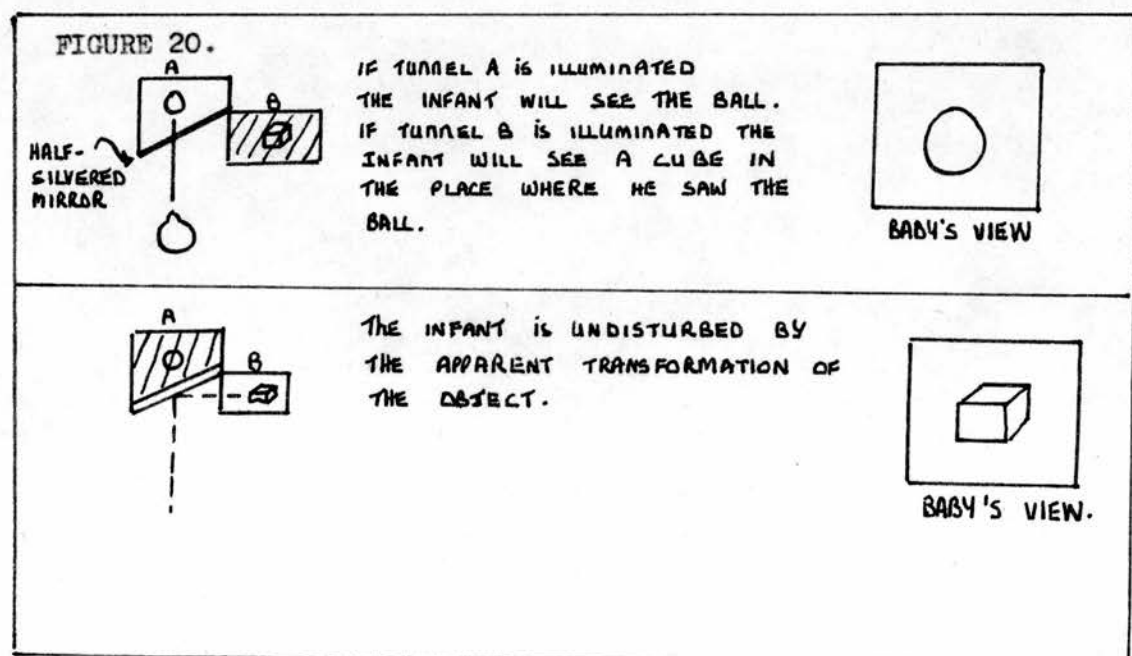
Rule Ib. Two objects cannot occupy the same position in space. All objects seen in the same position are the same object.

Rule II. An object is a bounded volume of space which when moving along a particular path of movement is defined in terms of that trajectory.

Rule IIb. Two objects cannot occupy the same path of movement in space. All objects on the same path of movement are the same object.

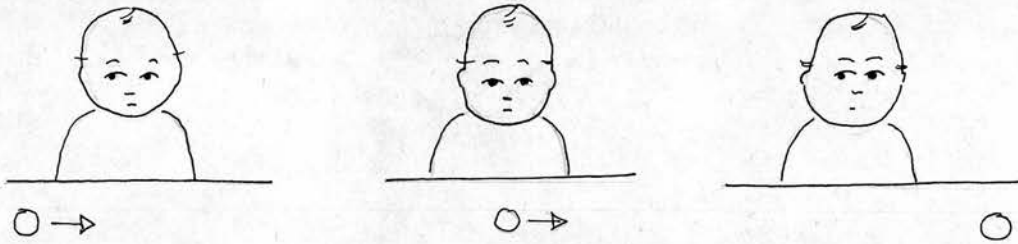
Evidence for the above rules comes from a series of experiments reported by Bower (1974). For example

Evidence for Rule I. If an object is replaced by another, the latter retaining the same spatial position as the former, the infant will not search for the original object although the eye movements required are within his repertoire (FIGURE 20)



(2) If an object is displaced in space the infant will look back to where the object was as if searching for the object although it is fully visible in a new spatial position (FIGURE 1:21).

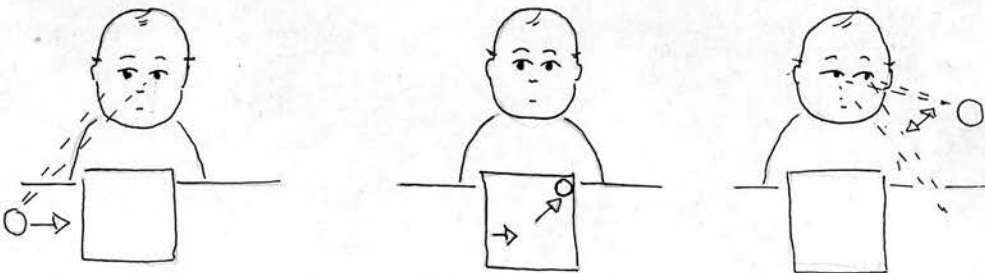
FIGURE 1:21.



Evidence for Rule Two

(1) If one transforms an object in motion the young infant will continue to track the object, seemingly accepting it as the same object. If by contrast the motion track of the object is changed the infant will look back and forth between the new and the old trajectory as if searching for an object other than the one which is currently visible (FIGURE 1:22).

FIGURE 1:22.



By the time the infant is 20 weeks of age Bower argues that he has co-ordinated his place and movement rules of object identity by means of progressively using featural information about the object. At 20 weeks then according to Bower the infant operates with a very adult-like rule of object identity.

Rule IIIa "An object is a bounded volume of space of a particular size, shape and colour which can go from place to place along a path of movement." (Bower 1974)^A As corollaries

Rule IIIb: Two objects cannot occupy the same spatial position at same time.

Rule IIIc: Two objects cannot occupy the same path of movement in space at the same time.

If we accept Bower's scheme, consider what these rules of object identity must mean for how the infant construes the Stage III-VI Object Concept tasks.

Stage III-IV transition task: In this task the infant is shown an object in place A. A cup or cloth is then introduced and the object is covered. The cup and the object now occupy the same position in space at the same time. Further all the boundaries of the object are enclosed within that of the cup. Such an occurrence is however a violation of Rule IIIb. The infant must thus see the Stage III-IV transition task as involving the mysterious replacement of object X by object Y (the cup) with no information as to the object's whereabouts. The object, from the infant's point of view has been effectively annihilated.

With experience in this test situation the infant may be considered, through his own actions or that of the experimenter, to be provided with information that conflicts with his initial judgement that the object has been annihilated. Often in the Stage III-IV task infants will pick up the cup for its own sake. Alternatively they will knock it over in their distress at the object's mysterious disappearance. From such actions, the object is revealed. If the infant also uses featural information in his criteria of object identity as Bower suggests, he, from such actions, is provided with information that the object he thought to be annihilated continues to exist. The problem for the infant is then - "If the object (X) continues to exist somewhere when it is replaced by Y, how can it be recovered?" The infant could learn from such accidents as described above, that the object may be recovered if the replacement object is contacted. He could formulate a rule of the form "To retrieve original object, contact and remove replacement object." There is however no causality in such a rule, no comprehension of the nature of the spatial relation that pertains between the object and the cup. Such a rule, would however, be a sufficient basis for the infant to succeed in the Stage III-IV transition task.

Stage IV-V transition task: the failure of the infant who successfully copes with the Stage III-IV task to cope with this task supports the argument that the infant's success in the former situation only reflects pseudo-understanding of the relationship of the object to the cup.

Traditionally in the IV-V transition task two identical cups or cloths are used. The object, defined by the infant in terms of its size, shape, colour and position is hidden under a container, A,

likewise defined. Faced with the mysterious disappearance of the object, the infant puts into play his rule "Contact replacement object to retrieve original object." The infant picks up container A and his magical rule is reinforced by being seen to work. This sequence occurs twice, the rule proves successful twice. The object is then moved to a different position on the table-top and is covered by container B. The object is seen to be replaced by yet another object. The child applies his rule "Contact replacement object to retrieve original object." This rule however is not specific enough for the task in hand. Two objects in the infant's visual field may be considered as replacement objects, container A and container B. As container A is identical in features to container B, it may be suggested that the infant's choice between them is based on the other aspect of their identity - their respective positions. Container A's position could be valued by the infant as contact with that container had previously led to the successful recovery of the object. Further looking for an object where it was last found is liable to be a search strategy that the infant would use in everyday life when he is faced with a situation in which he had no perceptual information as to an object's whereabouts: for example in the case where an object was moved when the infant had turned away from it. The appropriateness of container A as the infant's choice is however questioned by the fact that the infant has observed the object that he is searching for to have moved from the area of container A to that of container B. Container B thus competes for the role of replacement object.

This analysis would suggest that in the catch trial of the AAB Stage IV-V transition task, the infant is in a conflict between two

possible search strategies, neither of which reflect understanding of the relation of the object to the cup. This conflict is reflected in the fact that the infant's success in the Stage IV-V transition task remains at chance until the conflict is resolved. Success in the Stage IV-V task could be argued to occur through the infant generating a rule of the type "Contact replacement object in the area in which the object was last seen." This rule could be considered to be an advance over the Stage III-IV rule as now the object's last position is related to the choice of replacement object. Such a solution to the Stage IV-V task does not however involve a true understanding of the relation of the cup to the object. That this is the case, can be seen from an analysis of the infant's behaviour in the Stage V-VI transition task.

Stage V-VI transition task: In this task the infant is shown an object in place A. A cup or cloth then covers the object. Again we have violation of Rule IIIb of the infant's set of rules of object identity. However, in this task situation the object + cup is then moved to a different spatial position. Such an occurrence also violates Rule IIIc of the infant's set of object identity rules, namely that

"Two objects cannot occupy the same path
of movement at the same time."

The understanding of the relation of the cup to the object that the infant has developed through Stage IV-V testing may be shown to be totally inappropriate to this task situation. Application of the rule "Contact replacement object in the area in which the object was last seen in order to retrieve the latter" in this task situation leads

the infant to remove the wrong container for the object. Again, in this task situation the removal of correct container by the experimenter, or its accidental removal by the infant will reveal the object. Again the infant recognises the object as being the one which mysteriously disappeared. It has, however, changed its position from where it was last seen. But, according to the infant's rules of object identity the only way an object can change its position is by movement. In this task situation, the only movement the infant has observed is that of container A. Container A was however the replacement object that was originally in the area where the object was last seen. Its position and movement specifies that of the object. Thus if the infant puts these pieces of information together the relation of the cup to the object may be finally deduced.

Consideration of the rules of object identity that operate at 20 weeks of age thus lead to an alternative explanation of the infant's difficulty in the Stage III-VI Object Concept tasks. While it is true that these tasks involve the disappearance of an object, the above analysis suggests that it is not disappearance *per se* that causes difficulty for the infant but rather the manner in which the object is made to disappear. The relation object to occluder in these tasks involves the spatial relations 'inside' or 'under'. Such relations are argued to be incomprehensible to the infant as they involve the sharing of object boundaries and spatial position. Development through Stages III-VI of the Object Concept is thus suggested to be the development of the infant's understanding of the spatial relations 'inside' or 'under'.

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Development through Stages III-VI of the Object Concept is thus suggested to be the development of the infant's understanding of the spatial relations 'inside' or 'under'.

The above argument thus appears in principle to account for the infant's behaviour in the Stage III-VI tasks. Does it however have any advantages over alternative theoretical frameworks?

Most investigations of the development of the Object Concept have been predominantly concerned with explanations of the type of error the infant makes in the Stage IV-V transition task. They thus have focussed on a very small part of the total developmental sequence. By contrast, the proposed explanation of the infant's difficulty in the Stage III-VI transition tasks offers a framework through which the various stages in the developmental sequence may be seen as related to each other. It splits the development of the Object Concept into two Major parts. Part I, the Stage I-III tasks is argued to be primarily about the development of a conceptual understanding of an individual Object's identity. During this phase of development the infant is seen to struggle to co-ordinate his place and movement rules of object identity through the use of featural information about the object. Part II, development through Stages III-VI, is seen to be the development of the infant's understanding of spatial relationships between objects that involve the sharing of object boundaries. Progress through Stages I-III is however a necessary precursor of development through Stages III-VI. Only when an object is defined in terms of

its spatial position + path of movement + features can the occlusion of the object by a cup or a cloth be seen as an instantaneous replacement of the former by the latter. Prior to such a development, the object's occlusion by the cup would only be seen as a transformation of the former and therefore no problem of the spatial relationship between the object and the cup would exist. Further, utilisation of featural information about object identity, which is seen as an essential accomplishment of Stage I-III development, is seen to be the crucial basis from which the infant's development of an understanding of the spatial relationships involved in the Stage III-VI tasks evolves.

Secondly, the argument that the development of the Object Concept is primarily about the infant's conception of object identity has the following advantage over the traditional interpretation of the developmental sequence. As long as the infant's major difficulty in the Stage III-VI tasks is viewed as being one of conserving the existence of an object that is no longer visible, the relation between his incompetence in these tasks and his competence in handling various disappearance sequences prior to twenty weeks of age is incomprehensible. If however, the major source of difficulty in the Stage III-VI tasks is argued to be the type of spatial relationship that exists between the object and the occluder, disappearance sequences in which the object is not occluded by another object by being placed 'inside' or 'under' the latter should not provide the infant with such difficulty. Now, all of the disappearance sequences utilised in testing pre-twenty week old infants which involved an object being occluded by another object (rather than progressive transformation of the object itself) do NOT involve an object going 'inside' or 'under' another object. All these

sequences involve an object being occluded behind a screen (Bower 1967, Mundy-Castle & Anglin 1969, Bower, Broughton & Moore 1971). The spatial relation 'behind' does not involve the sharing of object boundaries such a relationship between objects does not violate the infant's rules of object identity. Further the optical information specifying X going behind Y and continuing to exist would appear to be innately transduced by the infant's perceptual system.⁵ Even the optical information available during Stage III-VI testing may be considered ambiguous. The cup or cloth in this situation generally covers the object by being moved from behind the latter. As its front edge comes over the object the object is behind that edge while being also in front of the back surface of the cup!

In sum the infant is argued to succeed with the disappearance sequences used in Bower et al's and Mundy-Castle and Anglin's studies and fail in the ones used in Stage III-VI testing because the former sequences involve the spatial relationship 'behind' between the objects whilst the latter sequences involve the spatial relationships 'inside' or 'under'. What is crucial in determining the infant's reaction to the occlusion of the object in the Stage III-IV tasks is not the fact of

5. On theoretical grounds Bower has argued that this must be the case if the infant is to see three dimensional space. He argues that interpretation of occlusion information is essential in order that the infant can disambiguate information about the spatial layout of the world that is produced by motion parallax and expansion pattern information (see also Gibson 1969), Bower (1976).

Harris, Cassel and Bamborough (1974) have demonstrated the importance of occlusion information in the world of young infants. The tracking behaviour of infants as old as twenty weeks of age was observed to be greatly disturbed if the moving object did not progressively occlude then uncover a background.

disappearance per se but the nature of the transition 'in sight' to 'out of sight'.

Thirdly this alternative explanation of the development of the Object Concept has the advantage that it avoids the necessity of postulating repetition in the developmental sequence. The disjunction in the infant's competence in dealing with the occlusion of an object by another object when eye movements are involved (Bower et al 1971, Mundy-Castle and Anglin 1969) as opposed to when reaching movements are involved as in Stage III-VI tasks, is explicable, as indicated above, in terms of the different spatial relationships existing between the objects in each case.

Finally it is a framework into which other theories of the development of the Object Concept can potentially be integrated. The information processing, the motor skill and the memory limitations of the infant during this development are no doubt, important. It is probable that such limitations contribute in some way to the characteristic errors the infant makes at each stage of the developmental sequence. In fact change in such capacities over time is likely to be the major reason why no one set of response strategies has ever been found to be capable of explaining the type of error made by the infant in the Stage IV-V transition task. Such limitations come into play however against the background of the two main conceptual problems that face the infant in the development of the Object Concept; the construction of rules of object identity and the understanding of the spatial relationships that can exist between objects. This thesis seeks primarily for evidence in support of these conceptual problems. It does not however deny the eventual need to consider in greater detail how processing limitations etc. relate to such problems.

Summary

In sum then this thesis argues that the reason the infant experiences difficulty in the Stage III-VI Object Concept tasks is to be found in the rules of object identity that the infant operates with at this age. These rules specify the conditions under which an object retains its individuality. They thus constrain the set of spatial relationships an object may enter into with another object without losing its identity. Spatial relationships which violate these rules of object identity by involving the sharing of object boundaries and spatial position are thus incomprehensible to the infant. Such relationships are involved in the nature of the transition of the object from **in sight** to out of sight in the Stage III-VI tasks. This thesis thus suggests that the major problem facing the infant in the Stage III-VI tasks is that of understanding the relationships between object and occluder. The fact that the object disappears from sight in these tasks may at best be considered a minor problem for the infant, at worse a totally irrelevant aspect of the situation.

CHAPTER II

EVIDENCE FOR THE IDENTITY HYPOTHESIS

2.1. Prediction I

If it is difficulty in understanding the spatial relation inside that is primarily responsible for the infant's failure to cope with the Stage III-VI Object Concept tasks, then simply placing one object inside another, even if this did not result in the disappearance of the former object, should elicit the same sequence of errors as occur with disappearance transitions involving the spatial relation inside.

This prediction, however would already appear to be invalidated. Bower and Paterson (1972) gave sixteen infants the Stage III-IV Object Concept task using both transparent and opaque containers. Ten out of sixteen infants removed the transparent container to obtain the object while only two out of sixteen did so for the opaque container. From this data Bower concluded that

".. the transparent container did pose problems but not enough to account for the difficulties with the opaque occluder."

The problems that the transparent containers produced Bower argued, reflected the difficulty the infant had in organising his reaching behaviour.

"The latency of picking up the transparent occluder when there was a toy inside was far greater than the latency to pick up the occluder alone, indicating that the cojoined response was far more difficult."
(see TABLE 2:1) COGNITION, I, No.2.

TABLE 2:1 (Bower & Paterson 1972)

Condition	N picked up occluder	Mean time to pick up occluder	N picked up toy	Mean time to pick up toy	N within free capture time
Opaque I	0	-	0	-	-
Transparent	14	115 sec	10	40	8
Opaque II	2	125 sec	2	35	2

Mean free capture time for object = 45 sec

Mean free capture time for occluder = 55 sec

It is possible however that Bower's explanation of the infant's difficulty with the transparent container is wrong. The latency effect could reflect conceptual difficulty with the spatial relation inside. If this is the case then infants of the same age should exhibit the same pattern of errors in Stage IV-V, V-VI testing with transparent containers as they do with opaque. Alternatively if it was motor difficulty alone that was responsible for the latency effect in Bower & Paterson's study, the infant should make no errors in Stage IV-V, V-VI Object Concept tests.

Experiment one evaluates these alternative hypotheses.

2.2. EXPERIMENT I

Subjects: Seven infants, average age 27 weeks 4 days, naive to the Object Concept tasks, served as subjects.

Materials: A variety of small brightly coloured objects were

used of average size 3 cms x 1.5 cms. The covering agents were transparent containers $4\frac{1}{2}$ cms x 3 cms diameter. These containers had been proved to be easily manipulable by infants of six months of age in a pilot study.

Procedure: the infant sat on his mother's knee at a table. The experimenter sat opposite. The infants were allowed a few minutes to play with the toys and the containers. This was done to discover the most favoured toy and to check that each infant had the requisite motor skill to manipulate the transparent containers. After this preliminary period the favoured toy was placed alone in front of the infant and slowly covered by the transparent container. During the process of covering the mother prevented the infant from reaching by gently holding him under the arm-pits. If the infant succeeded in removing the transparent cup within the time limits described by Bower and Wishart (1972) the test was repeated. If the infant was again successful the Stage IV-V transition test was given using two transparent containers. The test was given three times making a total of 9 trials. The side chosen for the initial covering of the object was randomised between tests. If the infant was successful in all three test presentations the Stage V-VI transition test was given. Again three presentations were made. Success was defined as 3/3 correct responses.

After this session the infants were seen weekly.

Testing began with the highest test the infant had passed the previous week. The criteria for passing the Stage IV-V and V-VI transition tests were adjusted upwards so that 6/6 correct responses

to each test was required before the infant was deemed to have passed the test. Weekly testing was continued for 6 weeks or until the infant could pass the V-VI transition test. At the last testing session with transparent cups all of the babies, save one who was sick, were run through the tests with opaque cups. Testing was limited to a 6 week period due to the onset of school holidays.

Analysis

Stage II Test - the infant was said to have passed this test if he could remove the transparent cup for the object within the time limits described by Bower + Wishart (1972).

Stage IV-V test

A correct response was the search and retrieval of the object at all positions during AAB testing. An error was searching for the object at A after it had been hidden at B. A response in which the infant looked to the wrong container and semi-extended his arm to pick it up on the catch trial before picking up the correct container for the object was scored as a 'don't know' response. This response was then classified as Pass or Fail depending on the proportion of pass or fail responses in a given session.

Stage V-VI test

A similar analysis was employed. Trials in which the infant failed to watch the complete transposition of the object were discounted.

In all cases trials in which the infant picked up the transparent

container and ignored the object, making no attempt to reach for it within 10 seconds, were discounted.

TABLE 2:2. Results of the longitudinal study of ability to cope with transparent cups

Subject	Age at onset		Age attainment	
	wks	dys	Stage V	Stage VI
A	21.4		24.4	n.a.
B	22.5		n.a.	n.a.
C	27.6		30.3	30.3
D	28.2		31.6	31.6
E	29.1		32.0	n.a.
F	30.0		32.1	33.1
G	30.2		33.0	35.0

n.a.: not attained

TABLE 2:3. Comparison of performance in object permanence tests done with opaque and transparent cups in Experiment I

Stage with opaque cups	Stage with transparent cups				
		III	IV	V	VI
	III			1	
	IV		1	1	2
	V				
	VI				1

Discussion

The results support the hypothesis that the 'inside' relation plays an important part in determining the infant's difficulty with the Stage III-VI Object Concept tasks. The results are not predictable from Bower and Wishart's arguments, nor do they support any 'memory' explanation of the infant's difficulty in the Stage III-VI Object Concept tasks.

Table 2:3 however suggests that the disappearance of the object in the traditional Stage III-VI tasks does still partially determine the infant's response. Performance in the Stage III-VI Object Concept tasks was poorer when opaque rather than transparent containers were used. The infants in Experiment One passed the Stage IV-V and V-VI tasks at a much younger age than infants do when tested longitudinally with opaque containers (TABLE 2:4).

TABLE 2:4

	TYPE OF CONTAINER	MEAN AGE PASS THE STAGE IV +V TEST	S.D.	No.of infants in sample	MEAN AGE PASS THE STAGE V -VI TEST	S.D.	No.of infants in sample
EXPERIMENT I	TRANSPARENT	30.6wks	1.3 wks	6	32.5 wks	1.0 wks	4
BOWER & WISHART'S 1972 LONGITUDINAL STUDY	OPAQUE	48.6 wks	-	33	59.5 wks	-	6

The infants' performance with transparent containers would thus appear to be superior to that with opaque.

However this conclusion does not necessarily follow from the data. In this study it is theoretically possible for the infants to have passed the transparent container tests by developing a contingent rule

of the type.

"To obtain an object with features X, Y, Z that has mysteriously 'disappeared' pick up the replacement object which shares these features."¹ This rule demands no comprehension of the spatial relationship existing between the object and the container but would be sufficient for success with transparent containers. It is an insufficient basis for the solution of the traditional Stage IV-V and V-VI transition tasks in which identical opaque containers are used. In these tasks there is no featural information available on which the infant could base his choice of replacement object. The infant could have developed a rule of the above type during longitudinal testing by correlating success in obtaining the object with a choice of the replacement container which was indexed by featural information that was common to the object. Figure 2:1 illustrates one type of behaviour pattern that was observed during Experiment I and which can be taken to indicate the infant beginning to base his choice of replacement object on the availability of featural information.

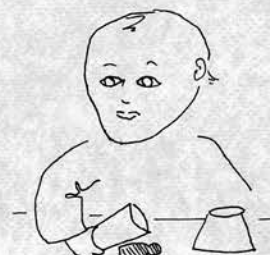
Figure
2:1



Infant observes the hiding of the object at B in an AAB sequence.



The reach is arrested as the infant is about to make the AB error.



The infant changes his orientation and correctly removes cup B for the object

1. That the infant is capable of using featural information about Object Identity at this age has been shown: Le Compte & Gratch (1971), Bower (1974).

If the infant's success in the Stage IV-V tasks was based on them choosing the container which shared featural information with the sought-after object, then implementation of this strategy in the Stage V-VI task would lead to practically instantaneous success in the latter. Examination of Table 2:2 and Table 2:4 shows this to be the case. Of the six infants who participated in the Stage V-VI task, four had solved the latter within the space of three testing sessions.

Such results suggest that the infant's success in Experiment I was a function of contingent rule formation.

Further support for this argument is to be found in the work of Brunskill (1971). In this study featural information was also available to cue the infant's search in the Stage IV-V, V-VI tasks. Instead of using two identical containers Brunskill used a pair of containers which differed in their colour, one being plain white, the other red. Again, as in Experiment I, the infants in his study quickly solved the Stage IV-V tasks. Further, success in the Stage V-VI tasks was almost instantaneous. On being given the standard Stage IV-V, V-VI transition tasks, the infants in Brunskill's study, like those in Experiment I, performed very poorly. There was no transfer of success between the two task contexts. Where featural information was available to cue the infant's search strategy, the infants appeared to be capable of using such

information to direct their actions appropriately and hence could avoid the problem posed by the relationship of the object to the cup.

In sum, if the infant's successful performance with transparent cups in Experiment I was merely a result of contingent rule formation as suggested above, there should be no difference in their ability to find an object placed inside a transparent as opposed to an opaque cup if a cross sectional testing procedure is employed. Experiment two was designed to see if this was the case.

2.3. EXPERIMENT II

Subjects. Twenty-seven infants between seven and 15 months of age were run through the Stage IV-V, V-VI Object Concept tasks with

opaque and transparent containers. Seventeen did the opaque test first while ten were run in the reverse order.

Analysis. The same type of analysis was used as in Experiment one. The stage the infant had reached in the Object Concept scale was determined by his ability to cope with the Stage III-IV, IV-V, V-VI tasks.

<u>Performance</u>	<u>Stage</u>
Fail Stage III-IV task	III
Fail Stage IV-V task	IV
Fail Stage V-VI task	V
Pass Stage V-VI task	VI

No infant was observed to pass the Stage V-VI task before he could pass the Stage III-IV and IV-V tasks.

TABLE 2:5. Results N = 27

		Stage with transparent cup			
		III	IV	V	VI
Stage with opaque cups	III	2	1		
	IV		4	1	
	V			12	3
	VI				4

The results are shown in TABLE 2:5. If the infant's difficulty with transparent containers was unrelated to that with opaque containers



nine infants would have been at the same stage by chance. In fact 22 were at the same stage. We can thus reject the null hypothesis that the two problems are unrelated ($\chi^2 = 28.04$ $df = 1$ $p < .001$). However five infants did better with transparent containers than opaque. The null hypothesis that this results from misclassification ($p = .031$ by binomial expansion test) can be rejected.

Discussion

The results of this study argue that the relative superiority of performance with transparent containers in Experiment One was an experimental artefact, arising from contingent rule formation during longitudinal testing. Disappearance per se would, however, appear to play a role, albeit a minor one, in Stage IV-VI Object Concept development.

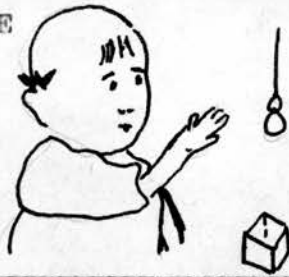
The results of Experiment Two have been replicated and confirmed by Butterworth (1976).

2.4. SUPPORTING EVIDENCE FOR THE IDENTITY HYPOTHESIS

There is another spatial relation that violates the infant's rules of object identity at this age, that is the relation placed upon. This relation involves two objects being in the same place at the same time. It involves the sharing of one spatial boundary. According to the identity hypothesis the infant should show Stage III-IV, IV-V, V-VI Object Concept type behaviour when dealing with this relation. That this is the case has been demonstrated by Piaget (1937) and Bower and Wishart (1976).

Piaget following the work of Szuman and Bailey (1927) observed that an infant of six months of age would reach quite happily for an object that was dangling in free space or placed upon a large surface area such as a floor or a table top. If the object was placed upon a small support the infant would however, react with distress and refuse to reach for the object at all, behaviour that is very similar to that observed when the object is hidden by a cup (FIGURE 2:2).

FIGURE
2:2



The infant reaches in
free space



The reach is withdrawn
and distress ensues



or the infant
reaches for object
+ platform as a whole

Alternatively the infant would reach out with his hand shaped to encompass the object + platform as a whole. If the object was then to drop off the platform the infant would react with surprise and distress (FIGURE 2:3).

FIGURE
2:3

THE TOY AND PLATFORM
ARE TAKEN AS A WHOLE.

DISTRESS WHEN THE
TOY DROPS.



Such behaviour suggests that the placing of X on Y was perceived by the infant as the disappearance of X and the reappearance of a new object $X + Y$ as predicted by the identity hypothesis.

Michotte (1962) and Bresson and de Schönen (1976) have however taken issue with this explanation of the infant's difficulty with the relation 'placed upon'. Michotte has suggested that the infant's difficulty with this relation is perceptual rather than conceptual in origin. If this was the case then the degree of surface contact between the object and the platform would affect the infant's behaviour. Unfortunately, the degree of common boundary between the two objects would also be predicted to affect the infant's response if the infant's difficulty was conceptual in origin. However, a perceptual explanation of the infant's difficulty would predict that if the infant was given the Stage IV-V Object Concept transition task with platforms no place errors would be observed. By contrast if the infant's difficulty with the relation 'placed upon' is conceptual in origin then such errors would be expected. Bresson and de Schönen take a similar line of attack to Michotte. They argue that the infant's difficulty with the relation 'placed upon' is perceptuo-motor in origin. The edges of the platform are argued to create motion parallax information which attracts the infant's reach from being directed towards the object, which produces less motion parallax towards the platform. In support of their argument Bresson and de Schönen point out that before the onset of visually guided reaching infants will reach in a ballistic fashion for the object and remove it from the platform. Even later when the infant is unable to reach and remove the object from the

platform he will nevertheless attempt to remove it with his mouth. However this evidence does not constitute a sound attack on a conceptual explanation of the infant's difficulty with the relation 'placed upon.' Prior to the onset of visually guided reaching those infants who successfully removed the object from the platform by employing a ballistic reach did so only for 20% of the test trials (de Schöenen pers comm). Such a low success rate could merely reflect the operation of chance. Likewise if the infant responds to an object on a platform with his mouth he could be argued to be merely responding to "a protuberance on the platform" rather than an object whose identity was distinguishable from the platform. As with Michotte's argument, Bresson and de Schöenen's argument would predict that the infant would make no Stage IV-V Object Concept type errors if given the Stage IV-V transition task with platforms. It would also predict that the degree of contact between the object and the platform would have no effect on the infant's response.

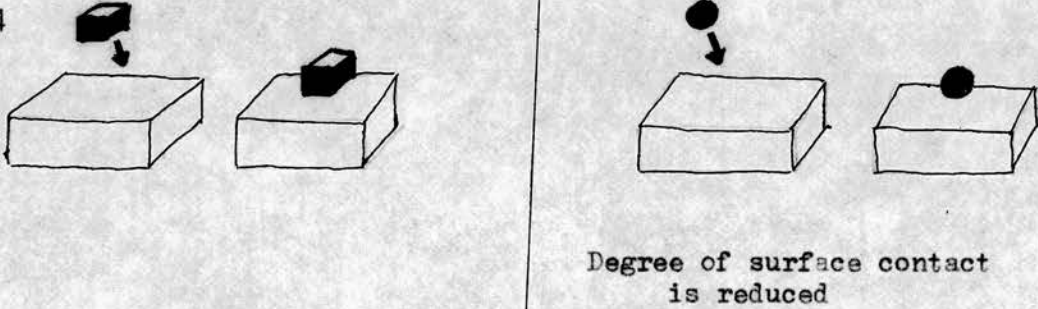
Michotte and Bresson and de Schöenen's criticisms of the 'loss of identity' explanation of the infant's difficulty with the relation 'placed upon' have been evaluated.

Bower and Wishart (1976)* have replicated Piaget's study, controlling for any difference between the motor requirements for reaching in free space as opposed to reaching for an object on the platform. They observed the same results as Piaget and farther observed that the amount of difficulty the infant had in reaching for the object on a platform was a function of how much common boundary the object and platform had (Bower 1977). A round object was easier to obtain than a square object (FIGURE 2:4). A result contrary to

* PERS. COMM.

that predicted by Bresson and de Schönen

FIGURE
2:4

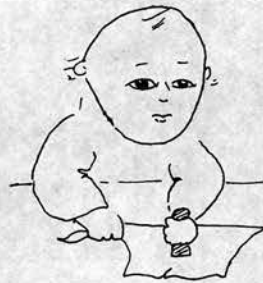


Bower and Wishart also extended their observations to Stage IV-V transition tasks with platforms, placing the object on one of two platforms rather than under one of two cups. The infants studied were observed to make Stage IV-V Object Concept type errors. Having observed the object placed on one platform twice, then placed on the other, they would search for the object on the original platform. This type of error suggests that the infant's difficulty with the relation 'placed upon' was of conceptual rather than perceptual or perceptual-motor origin as argued by Michotte, and Bresson and de Schönen respectively. 'Placed upon' does however appear to be an easier relation for the child to comprehend than 'inside.' No Stage IV-V errors were observed in infants beyond 34 weeks of age. (Bower and Wishart 1976). This was possibly due to the fact that the object shares only one spatial boundary with the support. Also, in this situation as in Experiment I, the object + support offers some of the featural information that characterised the object whose identity is lost.

The identity hypothesis would also predict that the young infant would be unable to comprehend that if an object was placed upon another object, movement of the latter object would also result in movement of the former object. That this is the case is reported by Piaget (1937). The young infant will not pull a support in order to obtain an object that is outwith reaching distance on the support (FIGURE 2:5). By six months of age he will pull the support in order to obtain the object (FIGURE 2:5a). If the object is now placed to the side of the support the infant will pull the latter and be surprised not to have obtained the object again (FIGURE 2:5b). Not until 10 months of age can the infant comprehend this task.

FIGURE
2:5

2:5a.



2:5b



SUMMARY

The studies reported in this chapter clearly demonstrate that even if the object is not hidden in the Stage III-VI transition tasks but rather placed inside a transparent container or on a platform in full view of the infant, he will nevertheless fail to search appropriately for it. Disappearance as a major source of difficulty in the Stage III-VI tasks is not disappearance due to an object moving out of sight but rather disappearance in the sense of the loss of the identity, individuality of an object when it enters into a spatial relationship with another object that involves the sharing of object boundaries and spatial position.

CHAPTER IIIFURTHER EVALUATION OF THE IDENTITY HYPOTHESIS

In Chapter I it was argued that the hypothesis that development through the later stages of the Object Concept was development of the infant's understanding of spatial relationships between objects that involve the sharing of object boundaries, had several advantages over alternative theoretical frameworks. One major advantage was argued to be the fact that it avoids the need to postulate repetition (Schaffer 1971) in the development of the Object Concept. The competence with which the infant handles disappearance sequences as assessed by his eye movements (Bower et al 1971, Mundy-Castle and Anglin 1969), as opposed to the incompetence he exhibits when his reaching behaviour is observed in the Stage III-VI tasks was held to be explicable in terms of the different types of spatial relationships that existed between objects involved in the disappearance sequence in each case. In the tracking studies the object moved behind a screen. It thus entered into a spatial relationship between objects that did not involve the sharing of spatial boundaries. This line of argument made several assumptions. It assumes that if the infant's understanding of the relationship 'inside' is assessed by observing the infant's reaction to an object disappearing into a tunnel, the results of such observations will also show that the infant does not understand the relation 'inside'. Nelson (1973) in a study, not actually designed for this purpose, observed this to be the case.

5-7 month old infants would not anticipate the reappearance of the object from within a tunnel. Likewise it is assumed that if the infant is given Stage III-IV and IV-V transition tests in which an object is made to disappear by being covered by a screen he will show none of the errors characteristic of Stage III-IV, IV-V transition test performance. He will be able to remove the appropriate screen to obtain the object from behind. This assumption has not been subject to empirical investigation. Its investigation constitutes the basis of Experiment III.

3:1. EXPERIMENT III

Subjects. Eleven infants, twenty-two to thirty-seven weeks of age served as subjects.

Apparatus. A variety of small toys
Two white screens 6 $\frac{1}{2}$ " x 5"
Two white cloths 8" x 5"

Procedure

Each infant was given three Stage III-IV transition tests with the cloth being used as the occluder. An object was placed in front of

infant, on a tray outwith the infant's reach. It was then covered by the cloth. The tray was then moved in towards the infant and his behaviour observed.

After these trials the infant was given a new toy. Stage III-IV transition testing was begun again. A screen was used to occlude the object this time. Three trials were again given.

Following this, the infant was given another two Stage III-IV transition tests with the cloth.

The order of presentation of this sequence was not varied on purpose.

If the infant could pass all the Stage III-IV transition tests, Stage IV-V testing began. Two Stage IV-V tests using the cloth as the occluder were given, followed by two Stage IV-V tests with screens. The side chosen as the A side in the AAB sequence was varied.

The complete session was video-taped for subsequent analysis.

Analysis

Trials in which the infant knocked over the screen + object, rather than reached for either were discounted. So too were trials in which the infant simply sat sucking the screen for more than one minute.

The infant was scored as successfully completing the Stage III-IV test with screens and/or with cloths if he

- (1) showed no surprise or distress to the disappearance of the object.

- (2) successfully removed the occluder for the object.
- (3) showed no distress or surprise to the reappearance of the object.

Surprise was taken to be indicated if

- (1) the infant's eyes widened
- (2) his eyebrows raised
- (3) his mouth fell into a shape
- (4) his body drew back from the toy.

Distress was indicated by

- (1) crying which was specific to the stimulus situation
- (2) agitated hand flaying
- (3) heavy frowning
- (4) withdrawal.

Results:

Of the eleven infants studied eight were at Stage III of the Object Concept Scale and three were at Stage IV.

Of the eight infants at Stage III seven removed the screen but not the cloth. The remaining one infant reacted with distress to Stage III-IV testing with cloths and with screens.

The three infants at Stage IV passed the Stage IV-V transition test with screens and failed the test with cloths.

These results are summarised in TABLE 3:1 (N=11).

STAGE ON CLOTH TEST	STAGE ON SCREEN TEST			
	III	III	IV	V
		1	7	0
ON CLOTH TEST	IV	0	0	3
	V	0	0	0

Thus the null hypothesis that behind transformations are as much of a problem as inside transformations may be rejected ($p < .05$ binomial expansion test). Such a result supports the hypothesis that the child comprehends the relation 'behind' before the 'relation 'inside' and that the behaviour modality used to assess comprehension of these relations is irrelevant.

However two of the seven infants who removed the screen but not the cloth in the Stage III-IV test were somewhat ambiguous in their behaviour. Although they showed no distress to the occlusion of the object and picked it up within fifteen seconds of removing the screen, the intentionality, goal directedness of their behaviour was difficult to assess.

Of the remaining five infants, four out of the five reached round the screen at least once for the object. Such behaviour questions Bruner's claim (1968) that infants of this age are limited to a reach along the line of sight.

Discussion

The results of Experiment IV support the premise that it is irrelevant whether eye movements or reaching is used to assess the

infant's understanding of the relation 'behind'. All of the infants' bar one demonstrated understanding of the relation 'behind' but not 'inside' in their reaching behaviour.

However Harris (pers comm) and Butterworth (pers comm) have argued that Experiment IV provides insufficient evidence for the validity of the above premise. They argue that the infants could cope with the Stage III-IV task with screens but not with cloths because removal of the former is a motorically easier task. This criticism does not of course apply to the infants' superior performance in the Stage IV-V task with screens. However as only three infants participated in this latter study the statistical significance of this result can hardly be evaluated.

To provide further evidence for the validity of the above premise the number of infants studied in the Stage IV-V transition task was increased by a longitudinal study of the infants who had participated in Experiment IV. If the above premise is correct it is predicted that the infants would have no difficulty in coping with the Stage IV-V transition task provided that the object was hidden behind a screen rather than hidden by a cloth. Experiment IV was designed to evaluate this prediction.

3.2. EXPERIMENT IV

Subjects: To the eleven infants who served as subjects in Experiment III were added another five infants, giving a total sample size of sixteen infants. The mean age of the infants studied was 32.3 weeks, the range of ages was from 22 to 45 wks.

Procedure The infants were seen weekly as far as possible. The infants who could not pass the Stage III-IV test with cloths were given this test weekly with screens and cloths until they could do so. They were then given the stage IV-V transition test with cloths and screens. Those infants who could, on the onset of this study, pass the Stage III-IV test with both types of occluders were given the Stage IV-V test on a weekly basis until they could pass this test.

The slide-in tray arrangement which had been used in Experiment IV was abandoned. Instead the mother was asked to prevent the infant reaching for the object while it was being covered by gently holding him under the armpits, the procedure which had been used in Experiment Two.

The criteria for passing the Stage IV-V transition test was upgraded to 3/3 correct AAB sequences on two consecutive weeks for both types of occluder.

Analysis

Stage III-IV test

If the infant unambiguously passed this test by removing the screen/cloth for the object he was given a score of two.

If he removed the screen or cloth but the intentionality of his behaviour, his orientation towards the object was dubious he was given a score of one.

If he failed the test completely he was given a score of zero.

A one way analysis of variance was carried out on the group scores as a function of occluder in order to determine whether the infants' performance in the Stage III-IV task with screens was superior to that with cloths.

Stage IV-V test

If the infant successfully retrieved the object on each trial of the two AAB tests he was deemed to have passed that test. If he made an error in either of the test sequences he was deemed to have failed that test. The infants' performance in this test when screens were used as occluders as opposed to cloths was evaluated by means of a one way analysis of variance.

Results

Of the 16 infants studied 8 were at Stage III of the Object Concept scale at the onset of testing. They were given the Stage III-IV transition task for five testing sessions i.e. until all had passed it. Table 3:2 summarises their performance during this period. It includes the results from Experiment IV.

TABLE 3:2. Results of One-way Analysis of Variance performed upon raw data.

Session	Group performance score with screens as the occluder	Group performance score with cloth as the occluder
1	12	0
2	8	2
3	10	6
4	12	12
5	16	16

TABLE 3:3 BASED ON FIRST THREE DATA POINTS .

Source	Sum of squares	df	Mean square	F ratio	F value
Treatments	80.6	1	80.6	<u>80.6</u>	12.0
Error	26.7	4	6.7	6.7	
Total	107.3				

For $\alpha = .05$ $df = 1,4$ F ratio = ~~7.7~~. As the obtained $F = 12.0$, the results are non-significant and the null hypothesis that there is no difference in the infants' performance with 'behind' transformations as opposed to 'inside' transformations ~~CAN~~ be rejected.

Stage IV-V testing

Table 3:4 compares the infants' performance in the Stage IV-V transition test when screens as opposed to cloths are used as occluders.

TABLE 3:4 (N = 16)

Session	No of errors made in the Stage IV-V task with screens	No of errors made in the Stage IV-V task with cloths
1	13	20
2	9	11
3	6	8
4	3	4
5	4	3
6	2	2
7	1	2
8	1	1
9	0	0

Results of One-Way Analysis of Variance on Table 3:4 - BASED ON FIRST THREE DATA POINTS.

TABLE 3:5

SOURCE	Sum of Squares	df	Mean square	F ratio	F value
Treatment	20.1	1	20.1	20.1/	.80
Error	102.7	4	25.7	25.7/	
Total	122.8				

For $\alpha = .05$ $df = 1, 4$ $F \text{ ratio} = 7.71$. As the obtained F is less than one the null hypothesis that there is no difference between the infants' performance in the Stage IV-V task with 'behind' transformations as compared to 'inside' transformations cannot be rejected.

DISCUSSION

The results of Experiment IV do not support the premise that infants of six to eight months of age can understand the relation 'behind' but not the relation 'inside' irrespective of what behaviour modality is used to assess their competence. The results support Harris and Butterworth's contention that the infants initial superior performance with screens in the Stage III-IV task, demonstrated in Experiment IV, [1] was merely a reflection of the fact that a screen is motorically easier for the infant to handle than a cloth. The infants' superior performance in the Stage IV-V task in Experiment II would appear to be an artefact due to the small sample size studied.

Curiously, as Table 3:6 demonstrates mixed practice with 'behind' and 'inside' relations appears to accelerate the infants' development through Stage IV.

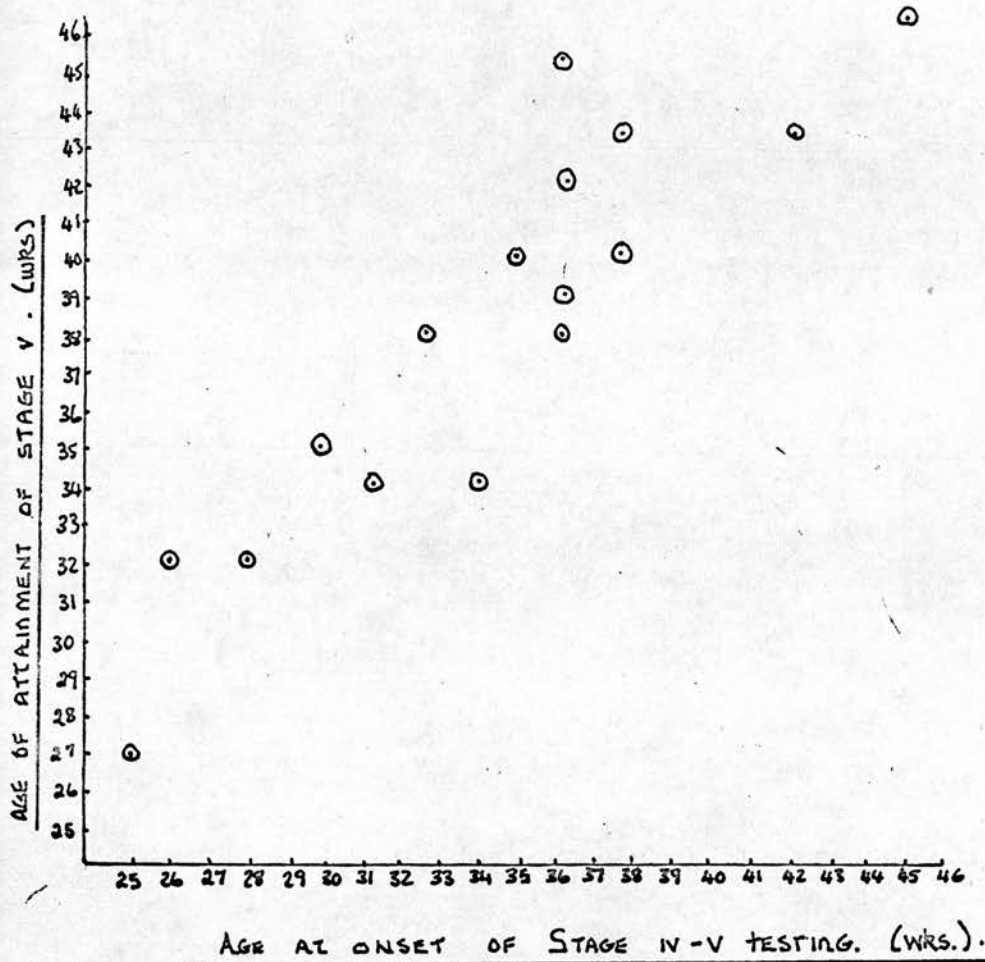
TABLE 3:6

	Average age at the onset of testing	S.D.	Mean age of attain- ment stage V	SD	N
Infants from Exp. IV	26.4 wks	3.8	34.1	3.9	8
* Infants given practice with cloths alone	26.0 wks		48.6		33

* From - Bower & Wishart (1972)

This suggests that perhaps successive testing with 'behind' and 'inside' relations in the same experimental session could have caused the infants' ability to cope with the former type of relation to deteriorate. If this was the case then infants of seven months of age, naive to the Object Concept tests, should have no difficulty in coping with the Stage IV-V test if screens alone were used as occluders. A short experiment tested this hypothesis. Four thirty-five week old infants were given the Stage IV-V transition test twice, with screens alone being used as occluders. All four failed this test.

Why the infants studied in Experiment IV showed accelerated development through Stage IV remains a mystery. As the number of infants tested in Experiment IV is small it could be that they were not a 'randomised sample'. They had perhaps previous experience of dealing with objects hidden under or behind things at home. That such experience affects development through the Object Concept Stages is demonstrated by Graph 3:1, drawn from the data of Experiment IV. The age at which the infant was exposed to the Stage IV-V transition task is clearly related to the age at which he/she attained Stage V.



As Graph 3:1 demonstrates age of onset of Stage IV-V testing was correlated with age of attainment of Stage V. For $\alpha = .05$
 $N = 16$ $\gamma = .35$ Obtained $\gamma = .80$

CHAPTER IV

PROBLEMS WITH THE IDENTITY HYPOTHESIS

DISCONTINUITY IN DEVELOPMENT?

The fact that the infant is as likely to err in the Stage IV-V Object Concept task when the object is hidden behind a screen as when it is hidden inside a cup or under a cloth challenges the model of the development of the Object Concept presented in this thesis.

This model assumed continuity in development. The problems of Stage I and II were those of developing criteria of object identity in terms of the object's spatial position, path of movement and featural characteristics. Resolution of these problems resulted in the infant being faced with new ones - those of relationships between objects. Each stage of the developmental sequence was characterised as a building block or stepping stone for the next.

The results of Experiment IV, however, suggest discontinuity in the developmental sequence. Understanding of the spatial relation 'behind', inferred from the infant's eye movements is clearly demonstrated by 4½ to 5 months of age (Bower et al 1971, Mundy-Castle and Anglin); would appear to be lost around 6 to 7 months of age (Exp.IV) only to return again around 8 to 9 months of age. These results thus give the appearance of repetition in the development of the Object Concept. This repetition appears specific to the infant's competence in dealing with the spatial relation behind as the work of Nelson (1973) reported

in Chapter III indicated no difference in the infant's understanding of the relationship 'inside' as a function of whether eye movements or reaching behaviour was used.

4.2. MODELS OF DISCONTINUITY

Why should the infant have any difficulty in coping with the relationship 'behind' in the Stage IV-V transition task?

One possibility, that offered by Schaffer, has already been discussed. He has argued that the knowledge that controls the infant's eye movements in Bower et al's studies is 'compartmentalized'. It does not initially control the infant's reaching behaviour as well.

Certainly support for this approach is to be found in studies of differences in the rate at which the infant will habituate to repeated presentations of an object as measured by amount of visual as opposed to manual exploration of the latter (Schaffer 1971).

However, this type of argument does not appear capable of dealing with the data at hand. If Schaffer's model was correct the infant would be expected to look to the correct screen on the catch trial of the Stage IV-V transition task but to reach to the wrong one.

Although such behaviour has been observed (Brown 1973, Wishart pers comm) it occurs infrequently. Generally eye and hand operate in a co-ordinated fashion in the Stage IV-V task.

Contained within Piaget's writings (1937) is however the suggestion that processes of conceptual development recur whenever a concept must be used on a different level. Generalisation of the

infant's understanding of the spatial relation 'behind' from tracking tasks to reaching tasks could, within this approach, be argued to pose a problem for the infant because of the eye - hand co-ordinated activity required in the latter task. This Piagetian approach to the phenomenon of repetition would suggest that the infant's ability to track an object behind a screen would also be poor if the object could also be reached for.

A third approach to this problem of apparent repetition in the development of the Object Concept may be found in the work of Bower (1974b). Bower points out that in certain instances of repetition in development such as those involving walking and auditory-manual co-ordination the infant appears to lose an ability. He suggests that the infant's poor performance in the Stage IV-V transition task may reflect total loss of the knowledge the infant utilised to cope with the tracking tasks at 5 months of age.

The Piagetian approach to this apparent repetition in the development of the Object Concept would thus suggest that the infant's ability to demonstrate understanding of the spatial relation behind would selectively deteriorate as a function of whether in such tasks the infant could reach for the object as well. The alternative approach, drawn from the work of Bower would predict that the infant's ability to track an object behind a screen would deteriorate at around 6 months of age irrespective of whether the object could be reached for or not. Experiment VI was designed to evaluate these alternative hypothesis.

4.3. EXPERIMENT V

Subjects: Twelve infants, naive to tracking tasks served as subject.

The infants were grouped according to age: 4-4½ months (N=4) 5-5½ months (N=4) 6-6½ months (N=4).

Procedure & Materials

A brightly coloured train was the object. It moved round a semi-circular track at a speed of 25 cms/sec. The radius of the track was $8\frac{1}{2}$ inches. At each end of the track were brackets which caused the train to stop or to reverse its direction of movement. The train could thus be kept in continuous motion. The track was nailed to a white table top in front of which the infant sat on his mother's knee. The infant's body midline was aligned with the centre of the track.

Two tracking conditions were employed. In Condition A the infant was given two warm up trials during which the object moved back and forth, in continuous motion, along the track. A white screen 8" x 6" was then placed in the centre of the track at a distance of $1\frac{1}{2}$ " from the rails. The infant was then given ten trials of the object moving back and forth behind the screen. His eye movements were recorded by means of a video unit.

In Condition B the infant was again given two warm-up trials. This time the object was stopped at each end of the track. The white screen was again placed in the centre of the track. The infant was then given ten trials of the object moving back and forth along the track. This time however the object stopped for seven seconds at each end of the track and the infant was permitted to reach for it. His eye and hand movements were recorded.

Each infant participated in both conditions. The order of presentation of the conditions was counter-balanced across babies. Between conditions the mother and infant played with each other for several minutes.

Analysis

The following scoring system was adopted.

- (a) If the infant failed to attend on a given trial he was given a score of zero.
- (b) If the infant searched for the object at either end of the track when it disappeared he was given a score of 1. This behaviour was argued to be comparable to that observed in Stage II-III of the development of the Object Concept (Piaget 1937) (Bower et al 1971).
- (c) If the infant stared at the edge of the screen behind which the object had disappeared he was given a score of 2. This behaviour is comparable to Stage III of the development of the object concept when the infant will not remove a cloth to obtain the object.
- (d) If the infant anticipated the reappearance of the object from behind the screen he was given a score of 3.

This scoring system may be argued to comprise an ordinal scaling system of the infant's tracking responses. Anticipating an object's reappearance from behind the screen is a more productive strategy than merely looking for the latter in its usual spatial position. The former type of response thus stands in the relation 'greater than' or 'better than' to the latter type of response.

Consequently the statistics used to analyse the data are as follows.

- (1) To examine the effect of condition on the infant's response the Wilcoxin Matched Pairs signed-ranks test was used as the same

infant participated in both conditions.

(2) To examine the effect of age on the infant's response the Kruskal-Wallis one-way analysis of variance by ranks was used as the infants tested were a cross-sectional sample. The infants tracking scores were summed across conditions in this analysis: no interaction of age and condition was predicted and examination of the data suggested none.

The level of significance was set at $\alpha = .05$ in both cases. In the Wilcoxin Matched Pairs signed-ranks test it was predicted that the infant's performance in the tracking condition in which he could not reach for the object would be better than that in which he could. Consequently a one-tailed test significance level of $\alpha = .05$ was used.

Results

TABLE 4:1: The effect of condition on the infant's tracking responses

Subject	Response Score Condition A.	Response Score Condition B.	d	Rank of d
1	21	23	- 2	- 3
2	20	8	+ 12	+ 12
3	18	16	+ 2	+ 3
4	20	13	+ 7	+ 10
5	17	26	- 9	- 11
6	27	26	+ 1	+ 1
7	27	30	- 3	- 6.5
8	27	29	- 2	- 3.0
9	11	14	- 3	- 6.5
10	19	22	- 3	- 6.5
11	19	24	- 5	- 9.0
12	20	17	+ 3	+ 6.5

Sum of ranks of positive sign = 32.5

Sum of ranks of negative sign = 45.5

$$T = 32.5$$

At $\alpha = .05$ and $N = 12$ T must be equal to or less than 17.

As observed T is greater than 17:

The null hypothesis that the infant's tracking performance is unaffected by whether the object can also be reached for cannot be rejected.

Conclusion: Whether the infants could/could not reach for the object while tracking the latter had no effect on their tracking behaviour. The Piagetian explanation of the apparent repetition in the development of the infant's understanding of the relation 'behind' is thus not supported.

TABLE 4:2 : Variation in the infants' tracking responses as a function of age

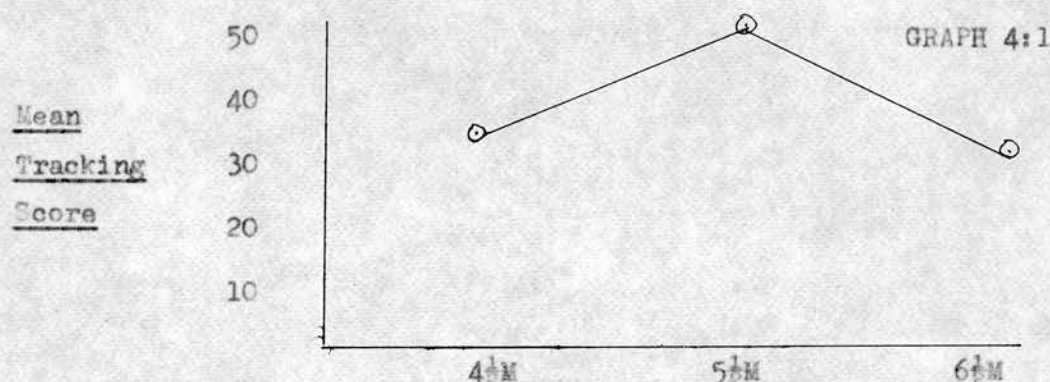
Subject	TRACKING SCORE		
	Age 6 - 6½ M	Age 5 - 5½ M	Age 4 - 4½ M
1	44	43	25
2	28	53	41
3	34	57	43
4	33	56	37
RANKS			
SUBJECTS .	Age 6 - 6½ M	Age 5 - 5½ M	Age 4 - 4½ M
1	9	7.5	1
2	2	10.0	6
3	4	11.0	7.5
4	3	12.0	5.0
Sum of ranks	18	40.5	19.5

Now,

$$H = \frac{12}{N(N+1)} \sum_{j=1}^k \frac{R_j^2}{n_j} - 3(N+1)$$

$$= \underline{\underline{6.08}}$$

At $\alpha = .05$ and $n_j = 4, 4, 4$. H must be equal to or greater than 5.6923. As the obtained H is greater than 5.6923, the null hypothesis that the infants' tracking responses do not vary as a function of age may be rejected. As Graph 4:1 clearly demonstrates the 5-5½ month old infants were more competent in tracking an object behind another than either of the infants in the other age groups.



Conclusion: The results of this analysis would appear to support Bower's argument that infants around 6 months of age begin to lose their understanding of the spatial relation behind.

The 4-4½ month old infants within this analysis are seen to be poorer trackers than the 5-5½ month old infants as they are still developing an understanding of this relation.

Discussion

These results do not show that competence in tracking an object behind a screen varied as a function of whether the infant could/could not reach for it, as was predicted. Interestingly, however, the 6 to 6½ month old infant is observed to be considerably poorer than the 5 to 5½ month old infant in tracking the object behind the screen. Not only do infants of this age appear unable to demonstrate understanding of the relation 'behind' in their reaching behaviour, they appear unable to demonstrate understanding of this relation by their eye movements either.

This latter statement must however be qualified. This experiment utilised the cross-sectional method of studying developmental trends. It is not certain therefore that the poor tracking behaviour demonstrated by the 6-6½ month old infants reflected a decline in their ability to comprehend the spatial relation 'behind.' We do not know that they ever possessed this ability. Variation in rates of development could theoretically be responsible for the observed decline in performance. Two facts support this argument. Firstly only 4 infants were studied in each age group and secondly significant between subject differences were observed.

It could also be argued that Experiment V was not an adequate test of the hypothesis that it is difficulty in eye - hand co-ordination that is responsible for the infant's failure in the Stage III-V Object Concept tests with screens. Although in Experiment V, the infant was only permitted to reach for the object in one tracking condition both tracking conditions involved the object moving along a trajectory

that was within reaching distance. The postulated 'eye-hand' schema for object displacements behind another object could thus be argued to have been activated in both conditions. Thus the predicted difference in the 6-6½ month old infants tracking behaviour as a function of condition was not observed.

If the above argument is plausible, it is predicted that the infant would be unable to consistently anticipate the re-appearance of an object from behind a screen if the object moved along a trajectory that was within reaching distance. He would be able to do so if the latter was outwith reaching distance.

Experiment VI was designed to evaluate this hypothesis.

4.4. EXPERIMENT VI

Subjects

Twenty infants, 6½ to 8 months of age, served as subjects.

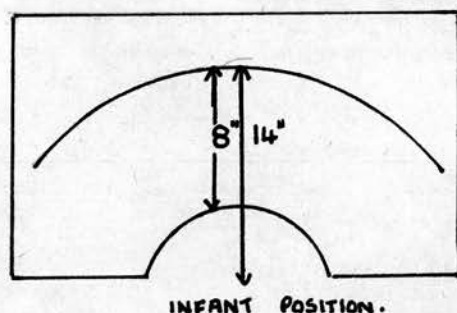
All were naive to tracking tasks.

Apparatus

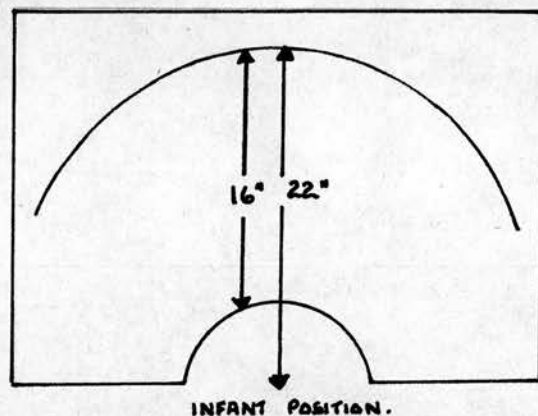
Two featurally identical Russian dolls of height 4½ and 8½ inches served as objects. The former was used in the Near Space condition, the latter in the Distant Space condition.

Object movement was effected by attaching the object to a steel pole that protruded through a semi circular groove cut on a table top. This pole was then connected to a Bodine Motor operated by a Power

Controller Unit. Two semi-circular grooves were used. In the Near Space condition a groove was cut at a distance of 14 inches from the edge of a table-top, a distance of 8 inches from the infant. In the Distant Space condition a groove was cut at a distance of 22 inches from the edge of a table top, a distance of 16 inches from the infant. FIGURE 4:1 illustrates this apparatus.



NEAR CONDITION



DISTANT CONDITION

FIGURE 4:1.

Two semi-circular frames made out of transparent perspex were used as screens. In the Near Condition the frame was of circumference 27 ins. and divided into three sections. The middle section, width 15 ins. was transparent while the outer sections were painted black, width 6 ins. each. The frame was $10\frac{1}{2}$ ins. tall. In the Distant Condition the frame was of circumference 36 ins. The middle section of the frame was 20 ins. in width, the two black outer sections were of width 8 ins. The ratio of opaque to transparent area of the frame in this latter condition was thus the same as that employed in the Near Space condition. The frame was 21 ins. tall.

In the Near Condition the frame was set at a distance of $\frac{1}{2}$ " from the groove along which the object moved. In the Distant condition it

was set at a distance of 1".

The apparatus was thus designed such that the projected size and shape of the object, its distance of separation from the frame, the height and relative areas of transparent to opaque sections of the frames, were kept constant in both the Near and Distant Space Conditions.

The object moved at a speed of 25 cms/sec in both conditions. The same rate of retinal displacement was thus maintained.

The design of the apparatus is shown in Figure 4:2.

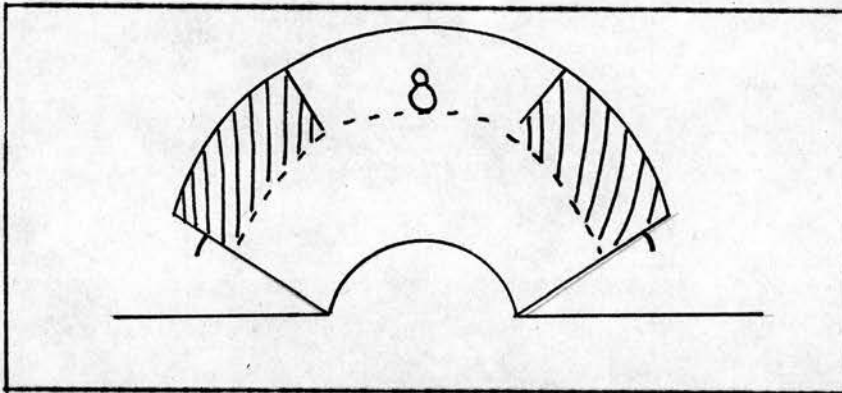


FIGURE 4:2

TRACKING COND.	NEAR SPACE	DISTANT SPACE
OBJECT SIZE	4 $\frac{1}{4}$ "	8 $\frac{1}{2}$ "
FRAME SIZE	HEIGHT: 10 $\frac{1}{2}$ " CIRCUM: 27"	HEIGHT: 21" CIRCUM: 36"
RATIO $\frac{\text{OPAQUE}}{\text{TRANSP.}}$	$\frac{12}{15}$	$\frac{16}{20}$
DISTANCE OBJECT/SCREEN	$\frac{11}{2}$ "	11"
DISTANCE OBJ. FROM THE INFANT	8"	16"
SPEED OF OBJ. MOVEMENT	25 cm/sec	25 cm/sec

The whole experiment was video recorded for subsequent analysis. A split screen was used. One camera was positioned above the track and filmed the object's movement. The other camera was positioned behind the background screen, its lens projecting through a hole in the latter. It recorded the infant's eye and hand movements.

Procedure:

The infant sat on his mother's knee at the table-top. The experimenter was positioned behind the background screen, operating the controls of the object's displacement. A video screen enabled her to determine the object's position on the track. The infant's mother was instructed to give the infant postural support where necessary but to allow him as much freedom of movement as was possible. The purpose of the experiment was not explained to her beforehand. She was warned that the infant might want to look at sections of the track other than where the object was. She was to allow him to do so.

Each of the twenty infants were assigned to one of the two tracking conditions. Each was tested in both conditions. A day separated each testing session.

In each condition the infant was given two warm up trials in which the object just moved back and forth along the track. Testing proper then began.




In the Near Condition the object moved along a trajectory which was within reach of the infant. The object was initially positioned at the centre of the track. The appropriate frame was then placed in front of the track. The object was visible at the centre of the

transparent section of the frame. The object was then moved from the centre of the track, position A, to the right or left of the track, position B or C. The object thus passed behind the opaque section of the frame. The object remained at B or C for 7 seconds during which time the infant was permitted to reach for it if he so wished. The object was then returned to the centre of the track and the movement sequence repeated. On the 3rd trial the direction of the object movement was changed. If it had moved from A to B on the first two trials it now moved from A to C. If it had moved from A to C on the first two trials it now moved to B. The sequence of object displacement is thus formally identical to that used in the Stage IV-V transition test with screens. Three such displacement sequences were given. The direction of the object's initial displacement in each sequence was randomised across the infants studied.

In the Distant Condition the object moved along a trajectory outwith the infant's reaching distance. The infant could thus no longer reach for the object at the end of the displacement sequence. Otherwise the procedure used in this condition was identical to that used in the Near Space Condition.

DISPLACEMENT SEQUENCE.

FIGURE 4:3.

TRIAL ONE	TRIAL TWO	TRIAL THREE
		
A - B	A - B	A - C

Results

None of the twenty infants studied attended to all three displacement sequences in both conditions. Three infants refused to attend at all in either condition. Four infants attended to all three displacement sequences in the Near Condition and two did so in the Distant Condition.

Variation in attention as a function of Condition and order of displacement sequence

As selective inattention could be a function of the infant's cognitive capacity to deal with an event (Kagan 1965 , Piaget 1952), a two way analysis of variance was performed to see if the infants' attention varied as a function of (a) condition, (b) which of the three displacement sequences the infant was observing. Between subject differences in attention was used as an estimate of error.

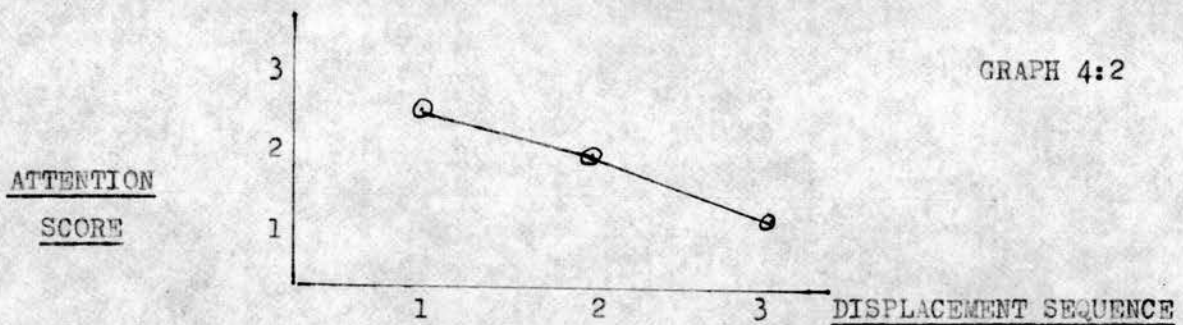
For each trial attended to the infant was given a score of one. Thus for each displacement sequence the infant could score a total of three points, nine points in all in each condition. Table 4:3 summarises the results of this analysis. The three infants who did not attend at all in either condition were excluded from analysis.

TABLE 4:3

SOURCE	SS	df	M.S.	Error Term	F ratio	F value	Sign
Condition (I)	.9803921	1	.9803921	LI	$\frac{.9803921}{3.063715}$.3200	NS
Displ.Seq.(K)	30.88232	2	15.44116	LK	$\frac{15.44116}{.7640905}$	20.2085	.01
Cond/Displ.Seq.	.72549	2	.3627472	LIK	$\frac{.3627472}{.5398002}$.6720	NS
Subject (L)	51.49007	16	3.218129				
Cond/Subj.	49.01944	16	3.063715				
Subj/Displ.Seq.	24.4509	32	.7640905				
Cond/Displ.Seq/ Subj.	17.27361	32	.5398002				

Whether the object moved within reaching distance or outwith was observed to have no effect on the infant's attention ($F < 1.00$).

The number of displacement sequences that the infant observed did have an effect on his attention in a later sequence as Graph 4:2 illustrates. The effect was observed not to interact with condition.



Tracking Behaviour

The lack of attention paid by the infants in this study made their tracking behaviour difficult to analyse.

4 types of responses to the displacement of the object behind the screen were noted.

(1) The infant simply looks away from the track or fails to attend at all.

(2) The infant searches for an object where it had been seen before i.e. at A (centre of the track) or at either end of the track B or C. Such a response is characteristic of the Stage II-III infant.

(3) The infant stared at the edge of the screen, the point where the object disappeared. Such a response is characteristic of the infant who fails the Stage III-IV task but passes the Stage II-III task.

(4) The infant anticipated the reappearance of the object by moving his eyes to the appropriate edge of the screen before the object reappeared or within 15 m/sec of its reappearance. Such a response is generally taken (Bower et al 1971) as indicating that the infant understands the relation 'behind'.

If whether the object moved along a trajectory in Near as opposed to Distant space, had an effect on the infant's response to the displacement of the object behind the screen, it would be predicted that the number of anticipatory responses made to the object in the distant condition would be greater than those made in the near condition.

In the case where the infant anticipated the reappearance of the object on the A trials of the AAB sequence in both conditions it would also be predicted that on the B trial the infant would fail to make an anticipatory response and instead look for the object where it had been previously found (A side) in the near condition but would continue to anticipate its reappearance in the distant condition. Unfortunately the infants generally changed their type of response to the displacement of the object between trials. This fact prevented a straight comparison of response strategies across conditions. Further as the infant's response to the A trials was not constant, change of that response on the B trials could not be evaluated. Consequently, two types of analysis of the infant's tracking behaviour were employed.

(1) The predominant response strategy used by the infant in each condition was examined. If whether the object moved within reaching distance of the infant detrimentally affected his tracking responses, then it would be predicted that if anticipating the reappearance of the object in the Distant Condition was his dominant response strategy

then he would change this strategy to one of the poorer types of responses in the Near Condition. This hypothesis was examined by means of the McNemar test for the significance of changes. The infant's dominant tracking strategy within each displacement sequence within each condition was separately scored.

(2) The infants' tracking strategies may be scaled in an ordinal fashion, identical to that used in Experiment V. Again if the movement of the object within reaching distance of the infant had a detrimental effect on his tracking behaviour, it would be predicted that the tracking strategies used by the infant in this condition would be poorer than those used in the Distant Condition. This prediction would be reflected in the infants' tracking scores being greater in the latter as opposed to the former situation. This hypothesis was examined by means of the Wilcoxin Matched Pairs signed ranks test.

Results

TABLE 4:4 Change in the infant's dominant tracking strategy as a function of condition

		NEAR CONDITION		
		OTHER	ANTICIPATION	
DISTANT CONDITION	ANTICIPATION	6	8	N = 51 sequences
	OTHER	28	9	

$$\chi^2 = .27$$

$$\text{For } \alpha = .05 \text{ and } df = 1 \quad \chi^2 \geq 3.84$$

Conclusion: As the observed value of χ^2 is less than 3.84 the null hypothesis that there is no difference in the dominant response strategy that the infant uses in the Near as opposed to Distant space condition cannot be rejected.

TABLE 4:5_A Differences in the infants' overall tracking scores as a function of condition

	TRACKING SCORE DISTANT CONDITION	TRACKING SCORE NEAR CONDITION	d	RANK of d
1	4	15	- 11	- 13.5
2	5	15	- 10	- 12.0
3	16	24	- 8	- 10.0
4	11	18	- 7	- 9.0
5	16	27	- 11	- 13.5
6	11	14	- 3	- 4.0
7	14	13	+ 1	+ 1.0
8	23	25	- 2	+ 2.5
9	16	14	+ 2	+ 2.0
10	0	20	- 20	- 2.0
11	12	6	+ 6	+ 6
12	7	1	+ 6	+ 6
13	23	27	- 4	- 4
14	14	5	+ 9	+ 9
15	15	0	+ 15	+ 15
16	0	6	- 6	- 6
17	6	6	0	

Sum of negative ranked signs = 92.5

Sum of positive ranked signs = 43.5

Direction of difference in the scores is contrary to that predicted

Observed $T = 43.5$. For $\alpha = .05$ and $N = 16$ $T \leq 30$.

Conclusion: As the observed T is greater than 30 the null hypothesis that there is no difference in the infants' tracking scores as a function of condition cannot be rejected.

Overall the proportion of anticipatory responses made to the Object's disappearance in the Near Space Condition was .49. The proportion of such responses observed in the Distant Space Condition was .42. As Table 4:5_B illustrates the proportion of anticipatory responses observed in

each condition was observed to be relatively constant. No significant difference was observed between conditions.

TABLE 4:5_e

Source	S.S.	df.	M.S.	F ratio	F value	Significance
Conditions	.03	1	.03	$.03/.025$	1.2	NS
Error	.09	4	.025			
Total	.12	5				

The infants' responses to the disappearance of the object on the catch trial of the AB, AB, AC displacement sequence was also separately examined. Rarely did the infants look for the object where it had been previously found (at B) on the A-C displacement trial. Table 4:6 summarises the frequency of this response type.

TABLE 4:6

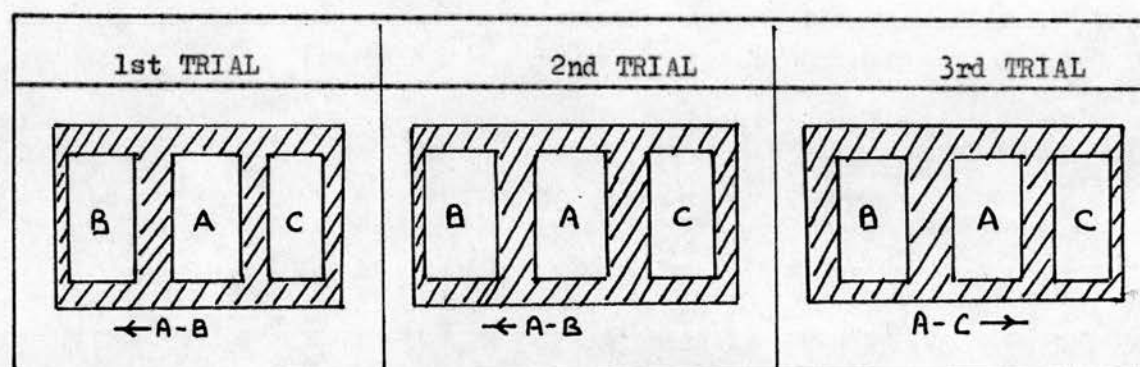
Proportion of Response Type	1st trial	2nd trial	3rd trial
Overall conditions	0.01	0.00	0.08
Near Space condition	0.03	0.00	0.10
Distant Space condition	0.00	0.00	0.04

Discussion

The criticism, that Experiment V was not an adequate test of the hypothesis that it is problems in eye-hand co-ordination that is responsible for infants of around 7 months of age failing the Stage IV-V task with screens, is not upheld by the results of Experiment VI. Whether the object moved along a trajectory that was within or without

reaching distance had no effect on his competence in dealing with the disappearance of the object behind a screen.

In Experiment VI the number of times the infants anticipated the reappearance of the object from behind the screen was considerably lower than that observed by Bower, Broughton and Moore (1971) in a similar study involving 20 week old infants (FIGURE 4:4). In this latter study the proportion of anticipatory responses made was 1.00 in contrast to the .49 and .42 result of Experiment VI .



Likewise in Experiment V the competence demonstrated by the 6 to 6½ month old infants was significantly lower than that demonstrated by the 5-5½ month old infants. These results suggest that, irrespective of the behaviour modality used to assess his competence, the 7 month old infant cannot demonstrate understanding of the relation 'behind' that he has, in some sense 'lost the ability' that enabled him to do so at 5 months of age.

4.5. A QUESTION OF LITERAL REPETITION IN DEVELOPMENT?

Is this suggestion feasible? One thing that it presumes is that the infant did, at some point in development, have to learn to understand the relation 'behind.' According to Bower (1976) the infant's perceptual system is tuned to decode the occlusion information specifying X moving behind Y from birth. He argues that interpretation of occlusion information by the infant is essential in order that the infant can disambiguate the information that is provided about the spatial lay-out of the world by motion parallax and optical expansion information (see also Gibson 1969).

Secondly in his studies of the development of the infant's rules of Object Identity during the first 5 months of life Bower (1974)^A observed that the infant never had any difficulty in understanding the relation 'behind' per se. As mentioned earlier if an infant of seven weeks of age observed an object being hidden behind a screen, he was surprised (heart-rate being used as an indicator) if the object was not to be found in its original spatial position when the screen was removed. The infant was not surprised however if the object's features changed while it was occluded. Likewise, the difficulty the infant of 12 to 16 weeks of age had in tracking an object behind a screen was attributed to the peculiar rules of object identity that he generated with. In the Bower, Broughton and Moore study quoted above the infant would look to B on the A-C displacement trial not because he did not understand the relation behind but because he identified the object in terms of its usual spatial position.

Thirdly if the argument is that the infant at seven months of age

has 'lost the ability' that enabled him to track an object behind a screen appropriately, what we are really saying is that the infant has lost the co-ordinated rules of Object Identity that he operates with around twenty weeks of age. We are suggesting that he returns, for some mysterious reason, to defining an object's identity in terms of its spatial location. This analysis does not seem feasible. If it was the case then the Stage III-IV Object Concept task would not pose any problem for the infant. Covering an object by a cup would be viewed as transformation of the object rather than replacement of the object by the cup, with no information as to where the object had gone. The infant would thus be expected to simply accept the cup as a 'transformed object'. The distress reactions observed when infants are given the Stage III-IV task certainly show that such 'simple acceptance' does not occur.

4.6. MOTIVATION, ATTENTION AND PERFORMANCE

An alternative approach to the results of Experiment V and VI is to suggest that either they are fluke results, the apparent decline in the infants' tracking abilities simply being a function of variation in rates of individual infants' development or that motivational changes are responsible for the decline in the infants' performance as a function of age. The infants' lack of attention in both experiments would fit with such an analysis. This lack of attention is in sharp contrast to the fascination with which infants of twenty weeks of age will attend to tracking studies. Subject variability observed in both studies could again reflect motivational differences.

However, if we accept a motivational explanation of the decline of the infants' performance in tracking studies at 7 months of age we are still left with the problem of accounting for the infants', of this age, failure to cope with the Stage III-IV and IV-V transition tasks when screens are used as occluders. Certainly a motivation explanation of this failure cannot suffice.

Further, the possible disjunction between the infant's comprehension of the spatial relation 'behind' when eye movements as opposed to reaching behaviour are used to assess competence, also suggests that perhaps infants of twenty weeks would be able to demonstrate understanding of the relations 'in' and 'on' if their eye movements, rather than their reaching behaviour, were used to assess their competence. The work of Nelson (1973) would appear to suggest that this would not be the case. However, Nelson used a cross-sectional method of sampling the infant's understanding of the relation inside at various ages. Further he did not report how well the infants attended to his tracking tasks. As indicated in this chapter variation in individual rates of development could well have affected the results of his study.

CHAPTER V

A RE-EXAMINATION OF THE DEVELOPMENTAL SEQUENCE

5.1. WHAT OTHER INFORMATION IS NEEDED

The model of the development of the Object Concept being proposed in this thesis has thus run into several difficulties. Possible variation in individual rates of development, possible motivational changes and variation in measurements of understanding as a function of the response system used, all appear to cloud the proposed picture of the infant's understanding of the relations 'behind' 'on' and 'in'.

The only way to resolve these problems is by means of a longitudinal study.

5.2. RULES OF OBJECT IDENTITY AND THE SPATIAL RELATIONS, IN, ON AND BEHIND

Firstly we need to establish the relation between the infant's changing rules of object identity (Bower 1974)^A and his developing comprehension of the relations 'behind' 'in' and 'on'. If

(1) the relation 'behind' is observed to pose difficulty for the infant which cannot be attributed to his having failed to co-ordinate place and movement rules of object identity.

(2) and that difficulty with the relation 'behind' occurs at the same time as 'difficulty' with the relations 'on' and 'in'.

(3) and that development of an understanding of these three relations is synchronous.

then it will be necessary to thoroughly review the model of the development of the Object Concept proposed in this thesis. This model does not predict any difficulty with the relation 'behind' as objects participating in this relation do not share spatial boundaries, occupy the same spatial position.

5.3. THE RELATION OF EYE MOVEMENT SEARCH STRATEGIES TO REACHING BEHAVIOUR.

Secondly, we need to establish the exact nature of the correspondance between the infant's competence as assessed by eye movements and as assessed by reaching behaviour.

5.4. PERFORMANCE VARIABLES AND THE QUESTION OF REPETITION IN DEVELOPMENT

Thirdly, we know from Experiments VI and VII that the infant's performance in tasks designed to observe his understanding of the relation 'behind' by eye movements deteriorates at around the age that the infant has difficulty in the Stage III-V tests with screens. We do not know if this apparent deterioration is a function of the cross-sectional testing procedure used in Experiments VI and VII. If it was, it would be predicted that in a longitudinal study of the infant's understanding of this relation no such deterioration would be observed. If deterioration in performance is observed, the problem then is to decide whether this is a function of motivational changes, such as boredom with tracking studies, or is in some sense a function of 'loss of competence'. If it is a function of the former variable

then no improvement in the infant's tracking behaviour would be predicted to occur when his competence in the Stage III-V reaching tasks improved. The infant's tracking behaviour would be more likely to be correlated with his degree of attention to the tracking task. If the observed deterioration was a function of the latter factor, improvement in the tracking task would be predicted to correlate with improvement in the reaching tasks.

5.6. WISHART AND BOWER'S STUDY

With respect to points one and two raised in the above discussion, Wishart and Bower (1977)^a studied a group of twenty-four infants on a weekly basis from twelve to twenty-eight weeks of age. Each week the infants were tested in two of the four possible tracking conditions: tracking an object to and fro, tracking the object through a tunnel, tracking it over a platform or finally, tracking it behind a screen. The infant's eye movements were thus used to assess his understanding of object identity and of the relations 'in' 'on' and 'behind.'

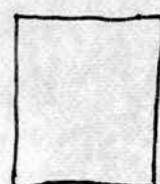
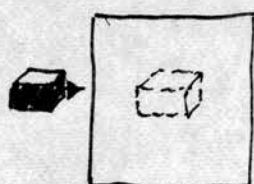
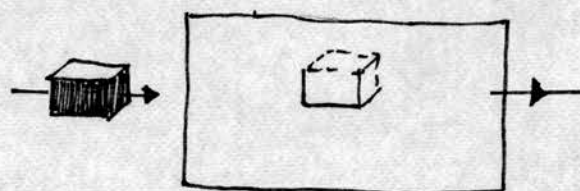
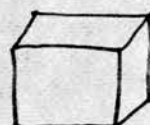
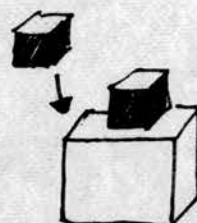
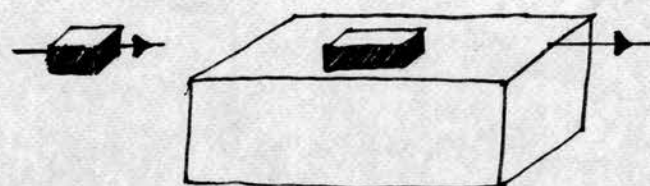
As soon as an infant was capable of reaching for an object placed on a large table-top, he was given the Stage III-IV and IV-V reaching tests with cups, platforms and screens. The reaching tasks were always given after the tracking tasks on a weekly basis, once started. Figure 5:1 summarises the design of this study.

* PERS COMM. REPORTED by BOWER (1976)^b

FIGURE 5:1

TRACKING CONDITIONS

REACHING CONDITIONS



Wishart and Bower (pers comm) report that initially the infants in this study, tracked the object through the tunnel, over the platform and behind the screen. They, however, also continued to track the object when it had stopped moving. Wishart and Bower (1977) thus concluded that this apparent ability to understand the relations 'in' 'on' and 'behind' was not genuine. The infants' response to these relations merely reflected the fact that, at this age, they defined the object in terms of its path of movement. By around sixteen weeks of age, the infants stopped tracking the object when it itself stopped moving, behaviour which indicated that by this age the infant had coordinated his place and movement definitions of object identity. So far, so good. The infants' tracking behaviour was in accordance with the rules of object identity attributed to them at this age by Bower (1974).^A At sixteen weeks of age, however, the infants became upset by the displacement of the object through the tunnel, over the platform or behind the screen. They either stared at the entry point to the tunnel, platform or screen as the object was displaced relative to the latter or they looked for the object at the end points of the track. However, after a few more weeks practise the infants could competently track the object through, over or behind the tunnel, platform or screen. Development of an understanding of the relations 'in' 'on' and 'behind' as assessed by eye movements was observed to be roughly synchronous.

Wishart and Bower further observed, that in the tracking tasks, the frequency of responses that were taken as indicative of an understanding of the relations 'in' 'on' and 'behind' declined from around twenty-four weeks of age. Thus the proportion of anticipatory responses made to the disappearance of the object inside the tunnel or behind the

screen dropped. So too did the proportion of times the infants smoothly tracked the object over the platform. This result suggests that the decline in the performance of the 6 to 6½ month old infants observed in Experiment V and VI was not a function of the fact that these two studies employed cross-sectional sampling techniques.

Transfer of understanding of the relations 'in' 'on' and 'behind' from the tracking to the reaching tasks was observed to be PERFECT, provided that the infant was exposed to the reaching tasks within a couple of weeks of demonstrating understanding of these relations in the tracking tasks. In saying transfer was perfect, Wishart and Bower mean that the above infants showed no difficulty in coping with the Stage III-IV reaching task and made no errors in the Stage IV-V transition tasks. If the onset of the reaching tasks was delayed relative to when the infant could cope with the tracking tasks, then transfer of understanding of the relations 'in' 'on' and 'behind' from the latter to the former was poorer. In such cases the infants were observed to make errors in the Stage IV-V tasks. However, the age at which these infants could cope with the Stage III-IV and IV-V reaching tasks was considerably advanced relative to infants who did not have any tracking experience prior to participating in these tasks, and curiously more advanced relative to infants who had extensive training experience. No simple monotonic relationship was thus observed between practice in eye movement tasks and performance in reaching tasks.

All of the infants studied by Wishart and Bower were observed to cope with the Stage III-IV and IV-V tasks prior to twenty-eight weeks of age.

Wishart and Bower's study thus calls for a revision of the model of the development of the Object Concept proposed in this thesis. The relation 'behind' is observed to pose difficulties for the infant that are not simply accountable by lack of co-ordination of the infant's place and movement rules of object identity. Further, understanding of the relations 'in' 'on' and 'behind' appears to develop synchronously, suggesting that each relation poses a similar problem to the infant.¹

Also contained in Wishart and Bower's study is the observation that the infants' tracking performance began to deteriorate around 24 weeks of age. This observation is relevant to point three raised in the opening discussion. The implication of this observation is that the deterioration in performance observed in Experiment V and VI was not simply a function of the fact that the cross sectional method of studying developmental trends was used. On longitudinal testing such a decline is also observed. The question then is does this decline reflect motivational influences such as changes in the infants' interest in the task or does it reflect some sort of decline in their 'competence' to understand the relations 'in' 'on' and 'behind'?

The fact that the infants in Wishart and Bower's study continued to competently cope with the Stage III-V test with cups, screens and platforms despite a decline in their tracking performance, argues against the latter explanation. The suggestion then is that change in motivational factors caused this change in performance.

In order to explore this suggestion more fully and to offer

1. Caution is required in evaluating this suggestion as the infant's comprehension of these relations was studied in the same experimental session.

further support for it, twelve of the infants who participated in Wishart and Bower's study were continued to be studied by myself over the period twenty-nine to forty-two weeks of age. Their performance in the tracking tasks was contrasted to that of a group of twelve naive infants of a similar age. None of the latter infants could cope with the Stage IV-V tests at the onset of testing. If the decline in performance in the tracking tasks was a function of motivational changes then it would be expected that a relatively close correspondance would exist between both groups of infants' attention and tracking performance. Secondly it would be predicted that the naive group of infants' performance in the Stage III-V tasks would improve to perfection during the study. This improvement in the reaching tasks would not be correlated significantly with any changes which may occur in their tracking behaviour. This study and these predictions constitute the basis of Experiment VII .

5.6. EXPERIMENT VII

Subjects: Two groups of infants were observed. The first group, referred to hereafter as the trained group, consisted of twelve infants who had participated in Wishart and Bower's study. They could competently cope with all the Stage III-V tasks at the onset of the study.

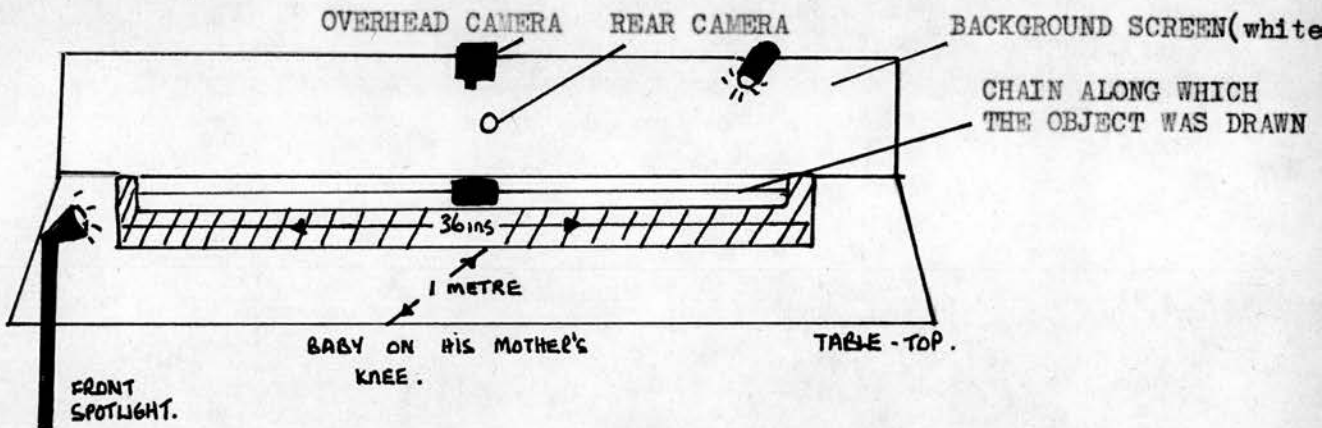
The control group consisted of twelve infants naive to tracking and reaching tasks. None of these infants could competently cope with all the Stage III-V tasks at the onset of the study. All could reach for an object placed on a large table top.

The infants were all in their twenty-eighth week of life at the onset of the study.

Apparatus

Figure 5:2 demonstrates the apparatus used in the tracking tasks.

FIGURE 5:2



Dimensions of objects used

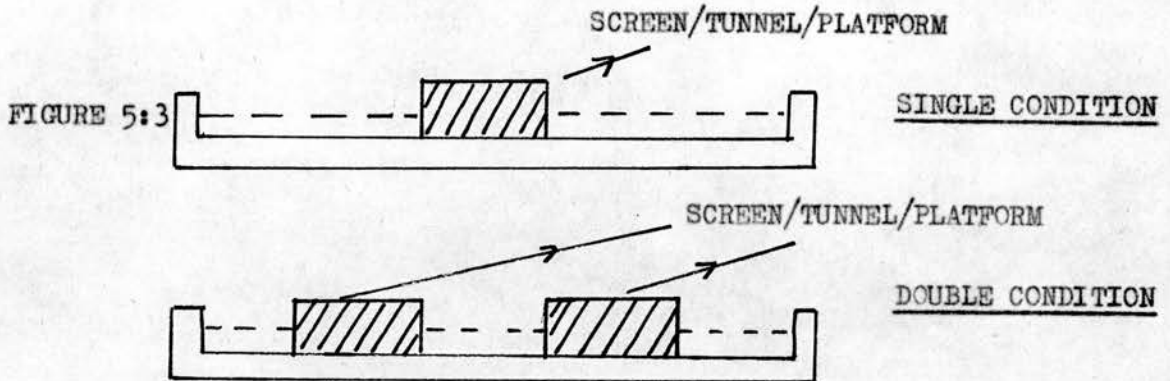
TABLE 5:1

	Tracking task	Reaching task
Screen	8" x 8"	6" x 4½"
Tunnel	8" circumf. x 8" from table	4½" x 8" circumference
Platform	2" x 3" from table	4" x 3"
Object	2" x 1" x 1½"	variable

Procedure

The tracking tasks were always given prior to the reaching tasks.

The tracking tasks were identical to those designed by Wishart and Bower with one difference. Whereas in Wishart and Bower's study the infant only had to track the object in relation to one other object, in this study an additional condition was employed wherein the infant had to track the object through/behind/over two tunnels, screens/ platforms in succession (FIGURE 5:3).



This procedure was employed to make the tracking tasks more comparable to the reaching tasks.

Each week the infant was tested in two of the four tracking conditions employed namely:

- (1) Tracking the object to and fro in free space for eight trials (A-B displacements).
- (2) Tracking the object through/behind/over one tunnel screen or platform for four trials followed by four trials in which the object moved through two of the former.

Order of presentation of the tracking conditions was counter-balanced by means of a Latin square testing design. During the period 28 to 42 weeks each infant was given six testing sessions in each condition. The infants were followed up on a roughly weekly basis. The tracking sessions were video-filmed for subsequent analysis.

In the reaching tasks, two trials of the Stage III-IV transition test with a platform/screen/cup were given. If the infant successfully removed any of the latter on both trials for the object he was given the Stage IV-V transition test. Two trials of this test were employed. Criterion of passing the Stage IV-V transition test involving a given

relation was 2/2 correct trials on two consecutive weeks. The order of presentation of each transition test with each relation was randomised.

Although the trained infants could pass both transition tests at the onset of testing, they were continued to be given these tests in order to keep the length of the experimental session constant for each group of infants.

Analysis

Tracking Data

The infants attention in each tracking condition was scored as follows.

One point was given if the infant watched the object move behind/onto/through the screen/platform/tunnel on a given trial. When only one 'occluder' was involved (S_1) the infant could score a total of 4 points. In the sub-condition where two occluders were used, the infants' attention in respect of each occluder was separately analysed (D_1 and D_2). Again 1 point was given for each displacement of the object relative to the occluder that was watched. Within this sub-condition a possible score of 4 was obtainable for D_1 and D_2 .

A four way analysis of variance was performed upon the infants' attention scores. This analysis tested the effect of the following on attention

- (1) Condition: Platform, Screen, Tunnel
- (2) $S_1/D_1 D_2$: Single 'occluder' first and second of the two occluders used.in the sub-condition.

- 39
- (3) Training: Previous experience in the tracking tasks v no previous experience
- (4) Session: The effect of time (and therefore practice) on the infants' attention.

The results of this analysis are summarised in Table 5:2.

Understanding of the relations 'in' and 'behind' was argued to be demonstrated if the infant consistently anticipated the emergence of the object from behind the screen or inside the tunnel. An anticipatory response was defined as one in which the infants' eyes were over at the exit point of the latter prior to the emergence of the object or within 15 m/sec of its leading edge emerging.

Understanding of the relation 'on' was argued to be demonstrated if the infant smoothly tracked the object over the surface of the platform.

In each condition, on each trial, the infant was given one point if he demonstrated understanding of the relation involved. The infants' scores in each group were pooled and expressed as a proportion of the total score that the infants could potentially obtain.

A four way analysis of variance was then performed upon these scores in an identical fashion to that performed upon the infants' attention scores.

The results of this analysis are summarised in Table 5:3.

Reaching Analysis

A successful response in the Stage III-IV and IV-V transition

tests was defined in the same manner to that used in Experiments IV, V.

For each Stage IV-V test successfully completed the infant was given 4 points: one for each of the first two successful recoveries of the object and two points for successful completion of the catch trial. For each relation the infant could thus score 8 points in the Stage IV-V transition test.

TABLE 5:2 4 Way Analysis of Variance: Attention Data

SOURCE	S.S.	df	MS	ERROR	F ratio	F value	SIGN
CONDITION(I)	2426.462	2	1213.231	IMKL	$\frac{1213.231}{50.65196}$	23.95	.01
S/D ₁ /D ₂ (M)	1038.907	2	519.4536	IMKL	$\frac{519.4536}{IMKL}$	10.26	.01
TRAINING (K)	592.676	1	592.6758	IMKL	$\frac{592.6758}{IMKL}$	11.70	.01
Sessions (L)	3447.934	5	689.5867	IMKL	$\frac{689.5867}{IMKL}$	13.61	.01
IM	1353.924	4	338.4810	IMKL	$\frac{338.4810}{IMKL}$	6.68	.01
IK	475.3528	2	237.6764	IMKL	$\frac{237.6764}{IMKL}$	4.69	.05
MK	308.4624	2	154.2312	IMKL	$\frac{154.2312}{IMKL}$	3.05	NS
IL	989.3040	10	98.93039	IMKL	$\frac{98.93039}{IMKL}$	1.95	NS
ML	457.8616	10	45.78615	IMKL	$\frac{45.78615}{IMKL}$	<1.00	NS
KL	480.6008	5	96.12016	IMKL	$\frac{96.12016}{IMKL}$	1.90	NS
IMK	121.5872	4	30.39679	IMKL	$\frac{30.39679}{IMKL}$	<1.00	NS
IML	755.2690	20	37.76344	IMKL	$\frac{37.76344}{IMKL}$	<1.00	NS
IKL	1458.859	10	145.8859	IMKL	$\frac{145.8859}{IMKL}$	2.88	.05
MKL	460.7463	10	46.07463	IMKL	$\frac{46.07463}{IMKL}$	<1.00	NS
IMKL	1013.039	20	50.65196	IMKL	—		

TABLE 5:3 4 Way Analysis of Variance of Anticipatory Responses

SOURCE	S.S.	df	MS	ERROR	F ratio	F value	SIGN
Condition(I)	1720.907	2	860.4536	IMKL	$\frac{860.4536}{85.65314}$	10.05	.01
S/D ₁ /D ₂ (M)	1076.129	2	538.0647	IMKL	$\frac{538.0647}{IMKL}$	6.28	.01
Training (K)	3289.037	1	3289.037	IMKL	$\frac{3289.037}{IMKL}$	38.40	.01
Session (L)	3620.851	5	724.1702	IMKL	$\frac{724.1702}{IMKL}$	8.45	.01
IM	910.0359	4	227.5090	IMKL	$\frac{227.509}{IMKL}$	2.66	NS
IK	46.34888	2	23.17444	IMKL	$\frac{23.17444}{IMKL}$	<1.00	NS
MK	38.45874	2	19.22937	IMKL	$\frac{19.22937}{IMKL}$	<1.00	NS
IL	866.3054	10	86.63054	IMKL	$\frac{86.63054}{IMKL}$	1.01	NS
ML	937.7507	10	93.77507	IMKL	$\frac{93.77507}{IMKL}$	1.10	NS
KL	646.2820	5	129.2564	IMKL	$\frac{129.2564}{IMKL}$	1.51	NS
IMK	1383.811	4	345.9526	IMKL	$\frac{345.9526}{IMKL}$	4.04	.05
IML	3268.698	20	163.4349	IMKL	$\frac{163.4349}{IMKL}$	1.90	NS
IKL	2153.318	10	215.3318	IMKL	$\frac{215.3318}{IMKL}$	2.51	.05
MKL	1750.541	10	175.054	IMKL	$\frac{175.054}{IMKL}$	2.04	NS
IMKL	1713.063	20	85.65314				

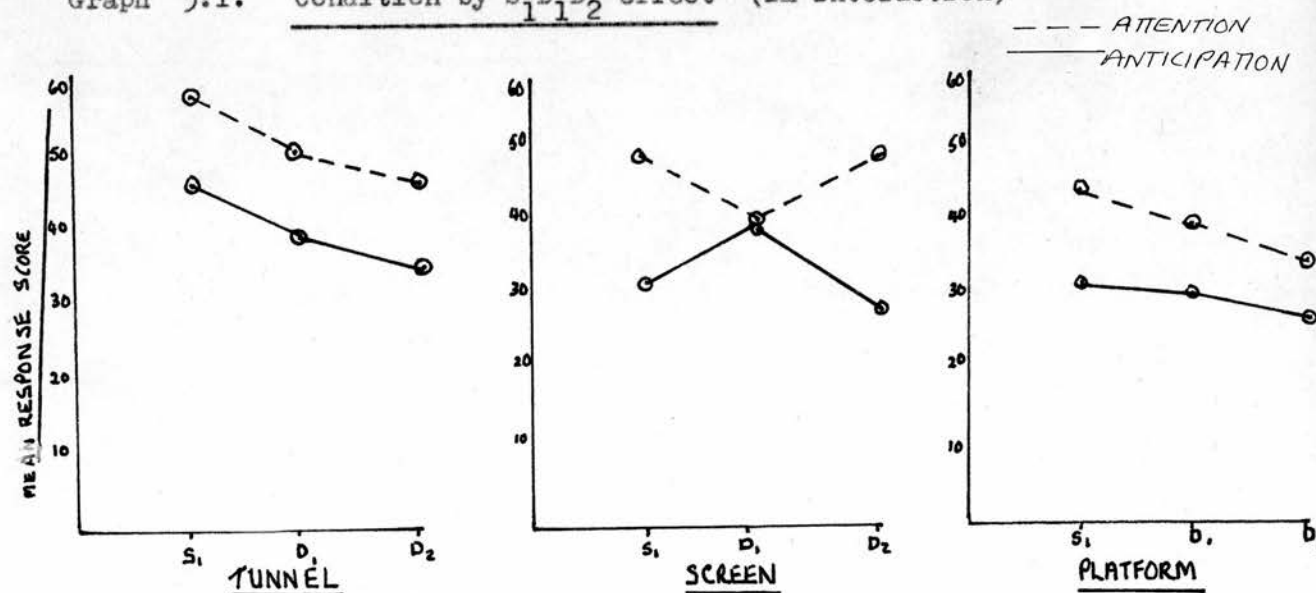
TABLE 5:4 Factors affecting attention contrasted with those affecting anticipation .

	Attention	Anticipation
Single Factors	Conditions ($\alpha = .01$)	Conditions ($\alpha = .01$)
	$S_1/D_1/D_2$ ($\alpha = .01$)	$S_1/D_1/D_2$ ($\alpha = .01$)
	Training ($\alpha = .01$)	Training ($\alpha = .01$)
	Session ($\alpha = .01$)	Session ($\alpha = .01$)
2 way interactions	Cond/ $S_1D_1D_2$ ($\alpha = .01$)	Cond/ $S_1D_1D_2$ ($F=2.66$)(N.S.)
	Cond/Training ($\alpha = .05$)	Cond/Train ($F = < 1.00$)
3 way interactions	Cond/ $S_1D_1D_2$ /Train($F < 1.00$)	Cond/ $S_1D_1D_2$ /Train($\alpha = .05$)
	Con/Train/Session($\alpha = .05$)	Cond/Train/Session($\alpha = .05$)

The effect of the single factors on attention and anticipation is illustrated in graph form in Appendix B. As these factors interact with each other their effects cannot be considered in isolation.

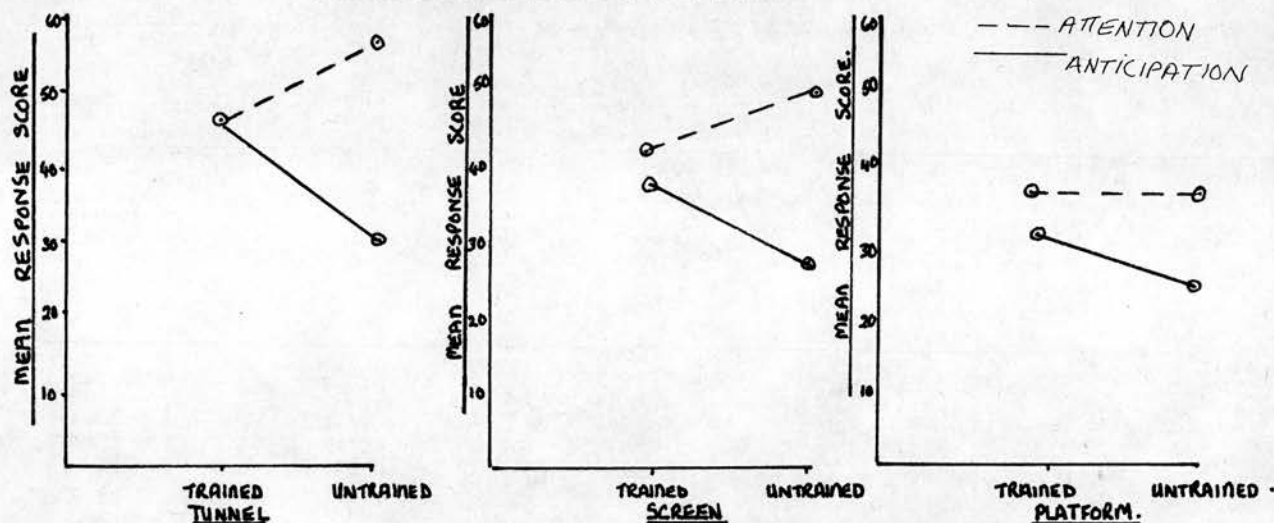
Graphs 5:1 and 5:2 demonstrate the effect of Condition by $S_1D_1D_2$ and Condition by Training interactions on attention and anticipation.

Graph 5:1. Condition by $S_1D_1D_2$ effect (IM interaction)



Although no simple linear correlation between attention and anticipation is observed, the form of the attention curve bears a strong resemblance to that of the anticipation curve in each condition.

Graph: 5:2 Condition by Training Effect (IX interaction)



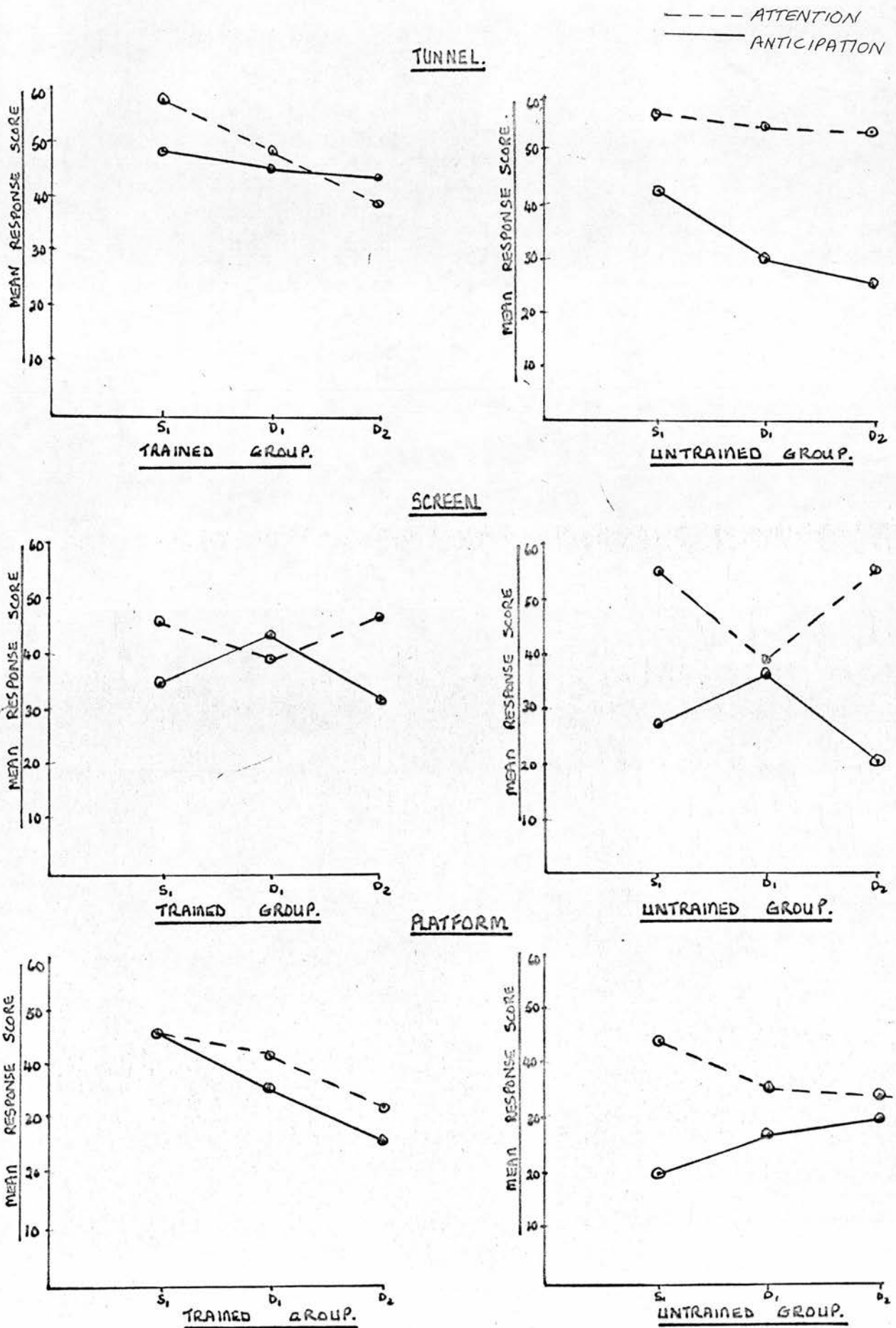
With the exception of the Platform condition, the trained group were less attentive than the naive or untrained group. In each condition however the performance of the trained group was superior to that of the untrained.

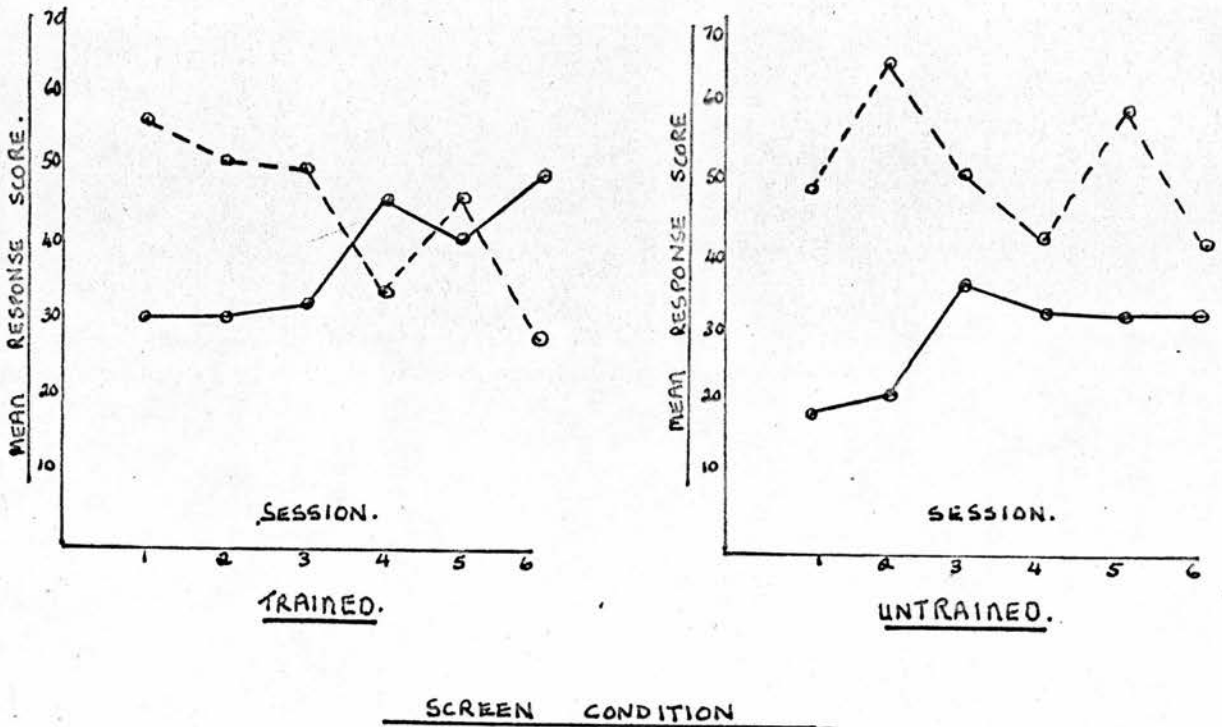
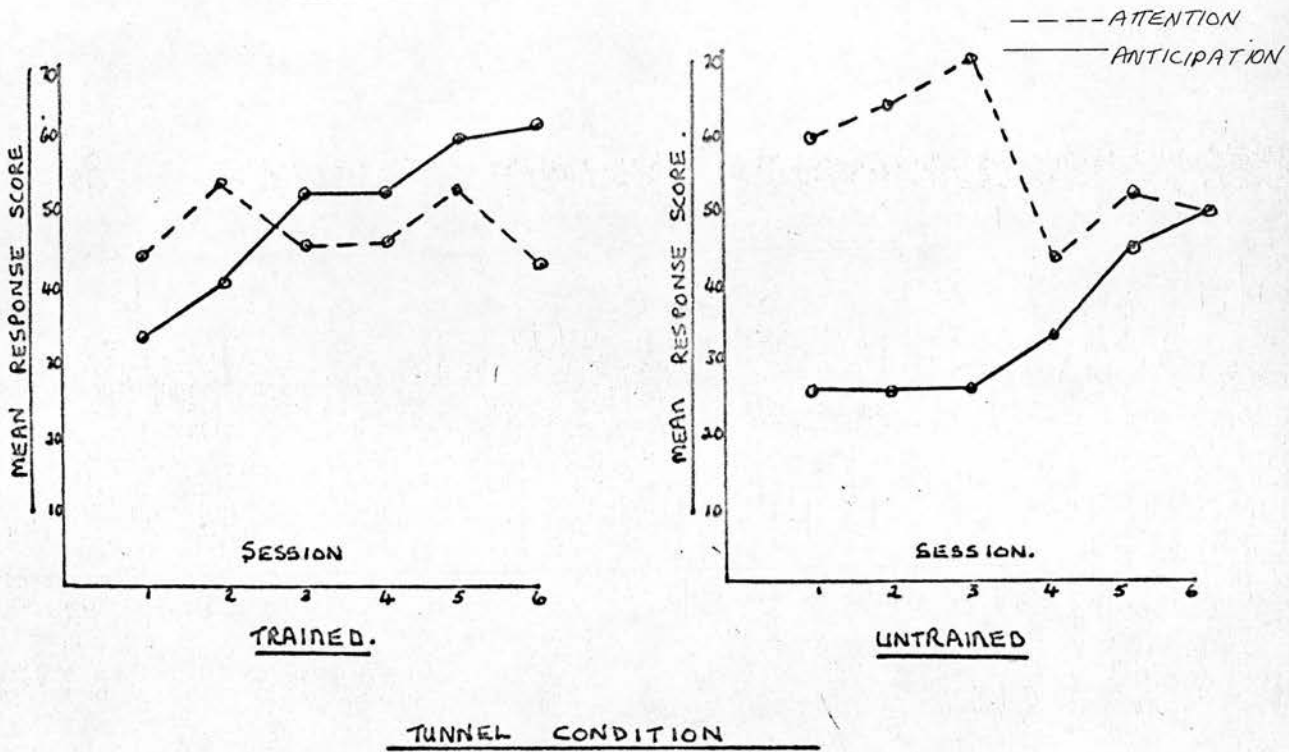
The relationship between attention and anticipation shown in these graphs is however complicated by the fact that 3-way interactions were also observed in this study.

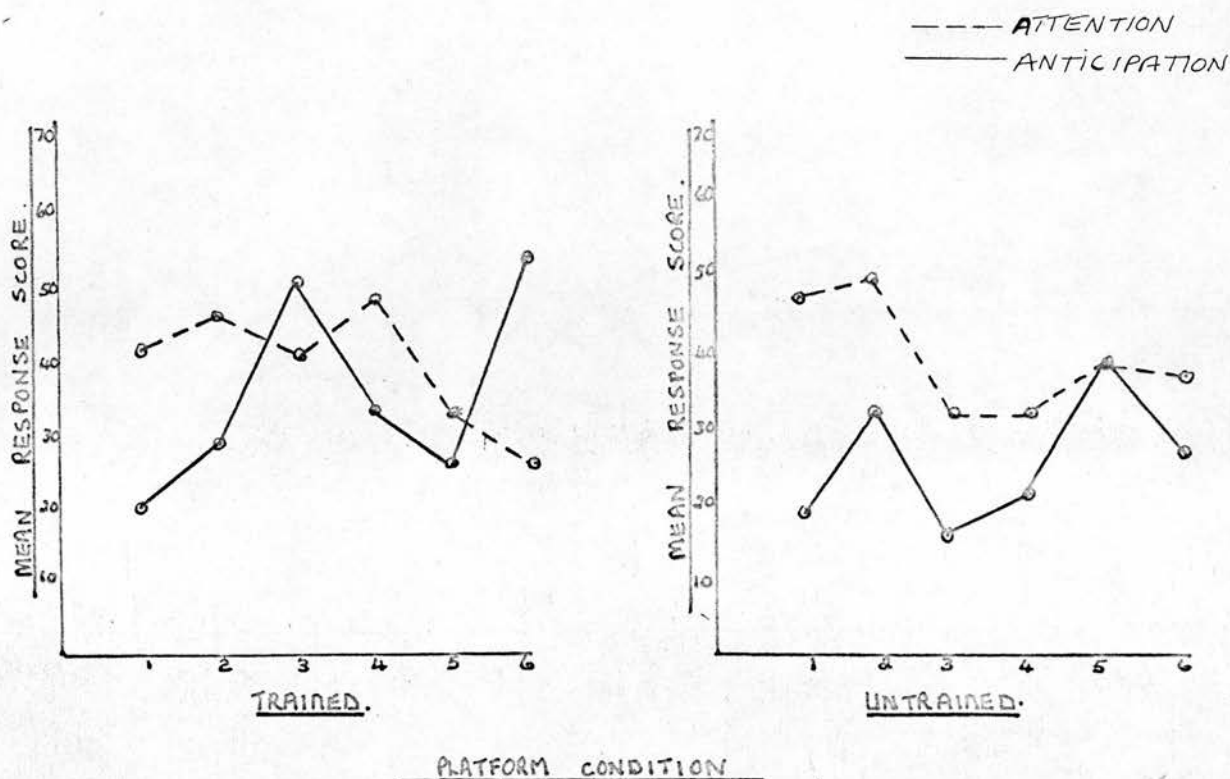
The effect of Condition and $S_1D_1D_2$ on the subject's behaviour is observed to interact with the effect of training. This 3 way interaction is only observed to have an effect on the subject's anticipatory behaviour. It did not affect their attention.

Similarly, the effect of Condition and Training on the subjects' behaviour is observed to interact with the effect of Session. This 3-way interaction affected the subjects' anticipations and attention.

These 3 way interactions are demonstrated in Graphs 5:3 and 5:4 respectively.

Graph 5:3. Condition by $S_1 D_1 D_2$ by Training effect (IMK)

Graph: 5:4. 3 way interaction Condition by Session by Training



The interaction Condition/Session/Training complicates the suggested relationship between attention and tracking performance. The latter does not simply deteriorate as the former declines.

However, no strong overall trend towards improved tracking performance is observed during this longitudinal study. The infants' tracking performance at the end of this study is still poor relative to that shown by younger infants at around 5 months of age. This fact suggests that the relative 'decline' in tracking performance as a function of age is due to motivational factors rather than competence changes.

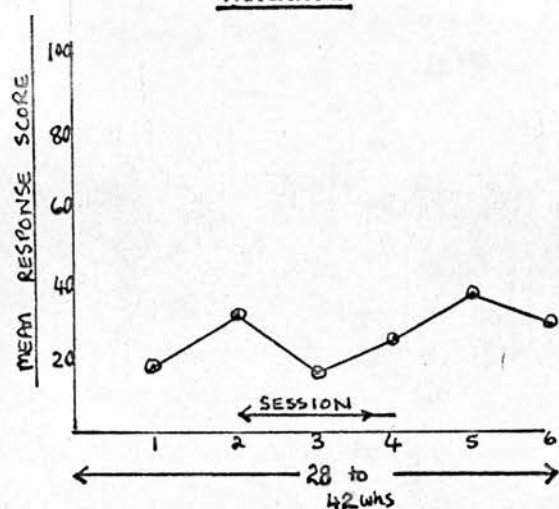
Further as the development of an understanding of the relations 'in', 'on' and 'behind' was found to be roughly synchronous (Wishart and Bower), if the infants' tracking performance declined as a function of competence change then this decline and eventual recovery would

again be expected to be roughly synchronous across the relations being tested. However tracking performance in this study is found to vary, as does attention, with the type of relation under study.

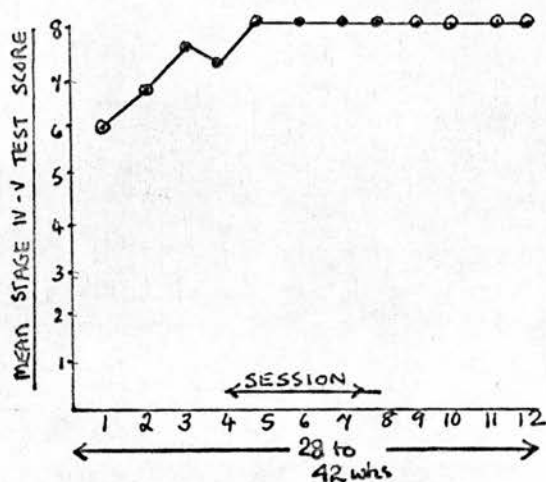
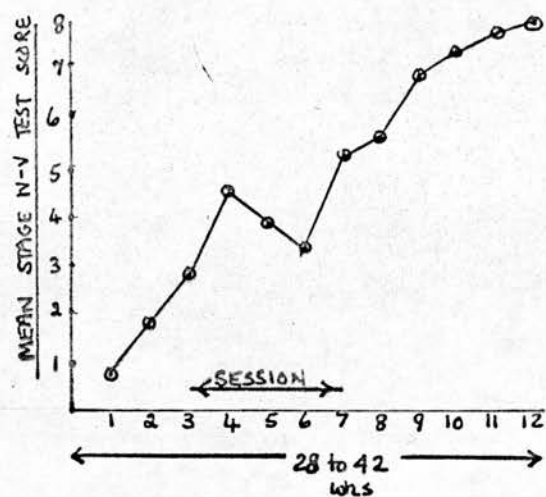
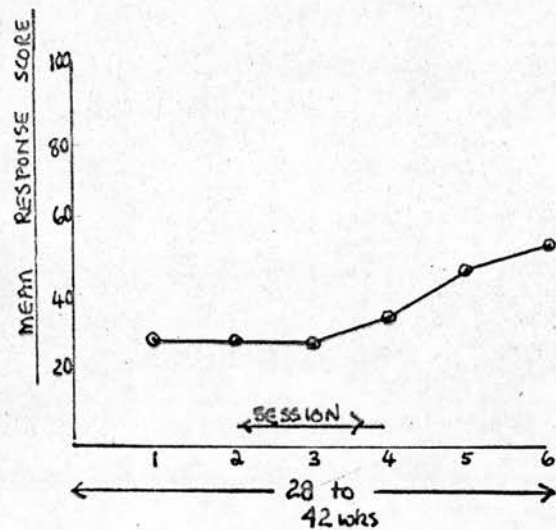
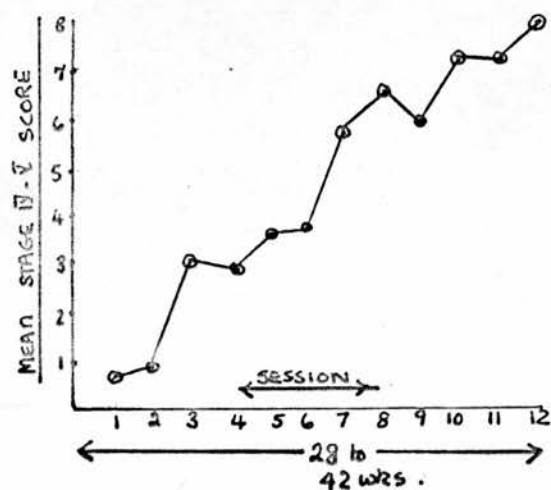
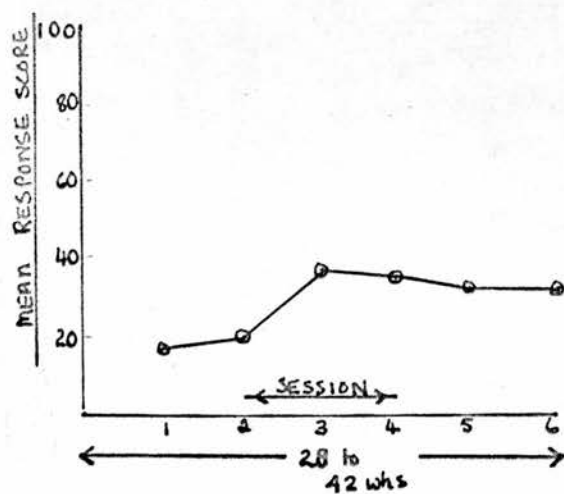
Relation of performance in tracking tasks to performance in reaching tasks

Finally, if we consider the relation between the infants' performance in the tracking as compared to the reaching tasks it is observed that the two bare little relation to each other.

In the naive group of infants studied in this experiment, none could cope with the Stage IV-V transition task with screens and cups at the onset of this study. Ten of the twelve infants could cope with the Stage IV-V transition test with platforms. By forty-two weeks of age, all of the infants could cope with the Stage IV-V transition test with cups, screens and platforms. Graph 5:6 contrasts these infants' reaching performance with their tracking performance. Again if their poor tracking performance was a function of the same lack of competence that was responsible for their failure in the reaching tasks, tracking and reaching performance would be expected to be correlated and to improve over the testing sessions. As can be seen from Graphs 5:6 this predicted correlation was not observed. Further while reaching performance was observed to improve to perfection during the longitudinal study the same is not true of tracking performance. The reaching profiles observed in this study are interesting. Performance in the Stage IV-V transition task with platforms is observed to be superior to that with screens and cloths.

"Relation Placed Upon"TRACKING

Graph 5:6.

REACHING"RELATION IN"RELATION BEHIND.

The reaching profiles for the latter two tasks are observed to be similar. Such a finding was also observed in Experiment IV.

The trained group of infants had demonstrated their competence in the Stage III-IV and IV-V reaching tasks prior to the onset of this study. This competence was maintained. In the 288 Stage IV-V transition tasks with cups these infants made a total of only 4 classical AAB errors, in 288 tests with screens a total of 3 AAB errors were made and in the 288 trials with the platforms only 4 classical AAB errors were made. By contrast the infants' performance in the tracking tasks remained poor during the period of study.

Conclusion

All the above observations would thus suggest that the poor tracking performance observed in Experiment V, VI and in Wishart and Bower's study by infants of around 6 months of age and in the above study is a function of changes in the infants' motivation towards the task at hand.

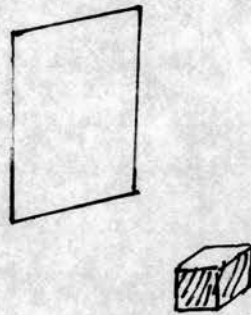
5.7. REVIEW

By far the most important study reported in this chapter in its implications for this thesis is that done by Wishart and Bower. Their study provided evidence that the spatial relation 'behind' would appear to present as much of a problem to the infant from sixteen weeks onwards as the relations 'in' and 'on'.

The proposed model of the development of the Object Concept would appear unable to account for this finding. The spatial relation 'behind' does not generally involve the sharing of spatial boundaries, spatial position between objects. Perhaps, however, the word 'generally' is crucial. There is a case when an object behind another object involves the sharing of a spatial boundary (FIGURE 5:4).



HERE, AS THE DISTANCE OF
SEPERATION OF OBJECT AND
SCREEN IS ZERO, THEY THUS.
SHARE A COMMON BOUNDARY.



HERE, THE DISTANCE OF
SEPERATION IS ZERO + ,
THERE IS THUS NO SHARING
OF OBJECT BOUNDARIES .

This case would appear however to be of purely academic interest as in reaching and tracking tasks designed to assess the infant's understanding of the relation 'behind' the object is generally placed at a couple of inches from the screen. (Few studies, including my own, specifically quantify and report this distance. Table 5:8 reports the estimated distances of separation used in this thesis).

TABLE 5:8.

Task	Distance of Separation
STAGE III+V REACHING TASKS (Exp.III-IV)	2 inches
EXPERIMENT V. (TRACKING)	1½ inches
EXPERIMENT VI. (TRACKING)	½/1 inch

It could however be the case that the distance of separation between the object and the screen is crucial. One last way of explaining the infant's difficulty with the relation 'behind' within the model of the development of the Object Concept proposed in this thesis is to argue that when the distance between the object and the screen is small (value α yet to be determined) then the object and the screen are seen as sharing the same boundary/position in space. This, as I have already argued is a violation of the infant's rules of object identity. The same argument would predict that the relation 'in front of' would also be a problem to the infant if the distance of separation of the object from the screen was $0 - \alpha$ ins. Experiment VII was designed to evaluate the above hypothesis.

5.8. EXPERIMENT VII

Subjects:

12 infants aged from 22 to 30 weeks of age served as subjects.

Mean age was 25.3 weeks.

Apparatus:

A cardboard screen 6 ins x 7 ins.

A bright red cubic toy with a ball in it of dimensions 2 ins x $1\frac{1}{2}$ ins x $1\frac{1}{2}$ ins.

Procedure

A reaching task rather than a tracking task was used to evaluate the hypothesis mainly because of the lesser time required to run the former.

The infant was given several warm-up trials in which he had to reach for the object and the screen at various positions on the table top. The infants' maximum reaching distance was observed to be roughly 8 inches.

The infant's understanding of the relations 'in front of' and 'behind' was then evaluated under two conditions. With respect to each relation the object was either placed against the screen or at a distance of 3" from it. 3" was the maximum distance of separation that could be used given the length of the infant's arm (\approx 9 inches) and awkwardness of reach - the object had to be at least 5" from the infant or he would tend to overshoot his reach. It thus had to be assumed that a distance of separation between object and screen equal to 3" was outwith the postulated critical distance 0 - ins.

Within each of these conditions the object was moved behind/in front of a stationary screen or the latter was moved with respect to a stationary object. Table 5:9 summarises the design of the study. One run through this design constituted eight trials. Testing consisted of three blocks of eight trials each whenever possible. Within each block of trials order of presentation of the conditions was counterbalanced.

The testing session was video-filmed for subsequent analysis.

TABLE 5:9

Condition	Relation	Distance of Separation	Trial ₁	Trial ₂
A	in front of	3"	Object move in front	Screen move behind obj.
B	in front of	0"	Object move in front	Screen move behind obj.
C	behind	0"	Object move behind	Screen move in front obj
D	behind	3"	Object move behind	Screen move in front obj

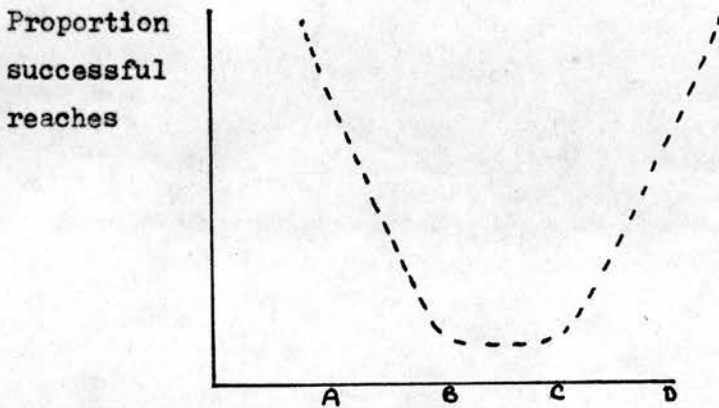
Prediction:

As there was no perceptible distance between the object and the screen in conditions B and C it is predicted that the infant would have difficulty reaching for and obtaining the object in these conditions. He would either refuse to reach or reach for the object and the screen as a whole.

In conditions A and D given that there was 3" of separation between the object and the screen the object would be clearly individualised to the infant. He thus would have no difficulty in reaching for and obtaining the object in these two conditions.

Thus the proportion of successful reaches observed in Condition A would equal that in Condition D and be significantly greater than that observed in condition B which would equal that observed in condition C (see Graph 5:7).

GRAPH 5:7



Analysis

The infant was deemed to have been successful in reaching for the object if he picked it up within 10 seconds of it being placed in front of the screen.

When the object was placed behind the screen the infant was allowed 30 seconds in which to reach for the screen. For his reach for the object to be scored as a success he had to reach for the latter within 10 seconds of removing the screen.

Results

Table 5:10 summarises the number of times the infant successfully obtained the object in each condition. The maximum score for each condition is 6.

TABLE 5:10

Subjects (I)	CONDITION(J)	CONDITION	CONDITION	CONDITION
	IN FRONT OF (FAR)	IN FRONT OF (NEAR)	BEHIND (NEAR)	BEHIND (FAR)
	A	B	C	D
1	6	6	1	4
2	6	6	1	2
3	6	5	2	2
4	6	3	2	3
5	6	6	3	3
6	4	5	1	2
7	6	6	4	4
8	6	6	3	4
9	6	5	1	1
10	6	6	6	6
11	6	1	2	1
12	5	6	4	3
Mean Score	5.75	5.08	2.5	2.92

A one-way analysis of variance to test for the effect of condition on the infants' reaching behaviour was carried out. As Table 5:11 demonstrates condition had a significant effect ($p = .01$) on their reaching behaviour.

TABLE 5:11

Source	S.S.	df	MS	Error	F ratio	F	Sign
Condition(J)	91.72916	3	30.57639	IJ	$\frac{30.57639}{1.212733}$		
Subjects (I)	41.06250	11	3.732954			25.21	=.01
Condition/ Subj (IJ)	40.0202	33	1.212733				

However, examination of Table 5:10 clearly demonstrates that the main effect of condition on the infant's reaching behaviour was not that predicted. The main effect of condition was whether the object was placed in front of or behind the screen and not the distance of separation between the object and screen.

However if the infants' scores in the Near Conditions are combined as in Table 5.II the distance of separation between the object and the screen is observed to have a significant effect at the .05 level (1 tailed test).

Table 5.II

Subject	Far Conditions	Near Conditions	d	d ²
1	10	7	+ 3	9
2	8	7	+ 1	1
3	88	7	+ 1	1
4	9	5	+ 4	16
5	9	9	+ 0	0
6	6	6	+ 0	0
7	10	10	+ 0	0
8	10	9	+ 1	1
9	7	6	+ 1	1
10	12	12	+ 0	0
11	7	3	+ 4	16
12	8	10	- 2	4
Mean Score	8.67	7.59	1.08	$\frac{49}{12}$

$$SD^2 = 49/12 - (1.08)^2 = + 2.89$$

$$t = \frac{1.08}{\sqrt{2.89/11}} = 2.12$$

At $\alpha = .05$ (one tailed test) $df = 11$ $t = 1.796$.

As obtained t is greater than 1.796 a significant difference between conditions is observed.

Discussion

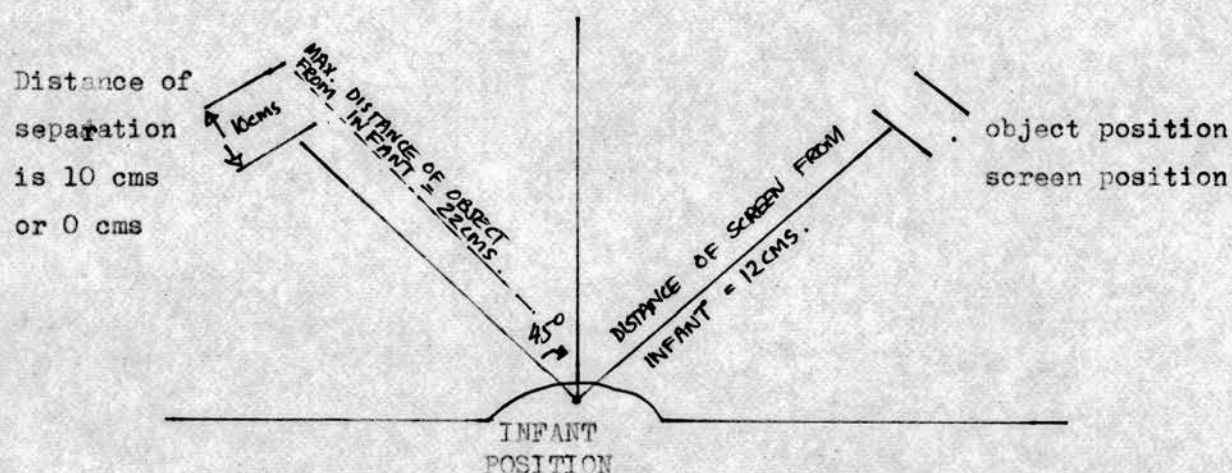
The results of Experiment 8 are not as clear-cut as one might have hoped. They do indicate that distance of separation of the object and the screen does affect the infant's responses but whether the object is placed in front of or behind the screen is of greater significance. In Experiment 8 an opaque screen was used. The difference between the in front of and behind conditions could thus relate to the fact that the object had disappeared in the latter case. Such an explanation however seems somewhat out of place in the context of this thesis. The studies reported in Chapter II indicated that disappearance of the object is not a major factor in the development of the Object Concept.

An alternative explanation of this result would be one which appealed to the limited motor skills of infants of this age. Independently of the distance of separation between an object and a screen, an object placed behind a screen poses problems of detour reaching which do not occur in the case of an object being placed in front of a screen. If this line of argument is correct it would be predicted if Experiment 8 was repeated, using both a transparent and an opaque screen, the main effect of condition would still be whether the object was placed in front of or behind the screen, independently of the distance of separation between the object and the screen. By contrast if it was the disappearance of the object behind the screen

that posed the major problem for the infant in the behind condition, the difference between the behind and in front of conditions obtained in Experiment 8 should disappear leaving the main effect of condition being the distance of separation between the object and the screen.

Such a study is currently being carried out by de Schönen and Bower (pers comm). As their study is not totally completed it may be reported in summary form only. Bower and de Schönen's experimental set up is illustrated in Figure 5.5

Figure 5.5



Screen Size = 10 x 15 cms
or 20 x 30 cms

Object Size = 2.5 cms
or 3.5 cms

They tested twenty two infants between the ages of five and ten months of age on their ability to reach for and obtain an object that was placed either in front of or behind a transparent or an opaque screen. The object was either positioned against the screen or at a distance of 10 cms from it.

Preliminary results confirm those of Experiment 8. The main

effect of condition on the infant's response was whether the object was placed in front of or behind the screen. This effect was independent of whether the screen was opaque or transparent. Such a result supports the argument that the relation behind is more difficult for the infant than the relation in front of due to the motor skill requirements of the former. Again the distance of separation between the object and the screen was found to significantly affect the infant's response in both the in front of and behind conditions. Again this effect was not as strong as the effect of these conditions themselves.

In sum then the results of Experiment 8 and those of de Schöenen and Bower offer tentative support for the proposal that the infant's difficulty with the spatial relation 'behind' may be incorporated within the general explanation of the infant's difficulty with spatial relationships that is offered in this thesis. The results however also strongly caution against the attempt to give a complete picture of the development of the Object Concept in purely conceptual terms. The need to integrate the conceptual changes involved in this developmental sequence with the other changes that are also taking place, such as motor skill changes, is strongly emphasised.

CHAPTER VIREVIEW OF THE IDENTITY HYPOTHESIS: CONCLUSIONS

The results of the experiments reported in this thesis are not totally congruent with the predictions that were made from the proposed reinterpretation of the development of the Object Concept. The aim of this Chapter is to examine the significance of these findings for the identity hypothesis, to see if the latter may be extended to incorporate all the information we have to date on the development of the Object Concept and to contrast the success this model has in dealing with the available evidence with that of alternative theoretical frameworks.

Traditionally, the development of the Object Concept is argued to be primarily about the growth of the infant's ability to represent objects that are no longer visible. This thesis argued that the development of the Object Concept should be viewed within a wider framework than this. Specifically it argued that while the tests used by Piaget to assess the infant's Object Concept generally involve the disappearance of an object the infant's responses in such tests were not simply determined by the fact that the object was no longer visible but rather by the nature of the transition from "in sight" to "out of sight". Thus the infant's difficulty in the Stage III-VI Object Concept tasks was attributed primarily to the type of spatial relation that existed between object and occluder in these tasks and not solely to the fact that the object disappeared from sight.

This hypothesis was derived from a consideration of the work of Bower (1967 onwards) on object identity. The infant's rules of object

identity were seen to constrain the set of possible spatial relationships that could exist between objects without an object losing its own identity. At around six months of age it was argued that the infant defined an object in terms of its boundedness, its spatial position, path of movement and featural characteristics. At this age, following the work of Bower, it was argued that the infant's rules of object identity forbade the sharing of spatial position or path of movement and boundaries between objects. However, it is precisely around this age that testing in the Stage III-VI Object Concept tasks begin. The nature of the transition 'in sight' to 'out of sight' employed in these tasks involves an object being placed inside or under an occluder. These spatial relations however involve the sharing of object boundaries and spatial position. As such it was argued that, in these tasks, the infant sees the object as being annihilated and replaced by a new object: the cup or cloth + object. Disappearance as a problem to the infant in the Stage III-VI tasks was not that of disappearance due to an object disappearing from sight but rather disappearance due to the loss of the object's identity when it shares its spatial boundaries with another. Thus of the three variables that appear to be involved in the Stage III-VI Object Concept tasks, namely:

- (1) the type of spatial relationship between the Object and the occluder
- (2) perceptuo-motor control of the infant's reaching behaviour
- (3) disappearance of the object from the infant's visual field.

Variable I was singled out by this thesis as the central problem facing the infant in these tasks. The characteristic errors made by the

infant in these tasks were thus argued to reflect strategies developed by the infant in his attempt to understand the relationship between object and occluder.

Consequently the core prediction made by this thesis was that the infant, at Stage III of the development of the Object Concept, would show similar difficulty to that observed in the Stage III-VI traditional Object Concept tasks in dealing with any spatial relationship that involved the sharing of object boundaries and spatial position irrespective of whether the object objectively disappeared from the infant's visual field and irrespective of whether the infant's tracking or reaching behaviour was used to assess his understanding of the relation in question. Prior to reaching Stage III of the developmental sequence, such relationships would not present any problem to the infant because of his lower level rules of object identity.

By contrast spatial relationships between objects such as that of an object being occluded behind another object would present no problem to the Stage III infant as this relationship does not involve the sharing of object boundaries and spatial position.

The results of the experiments reported in this thesis contradicted this core prediction in several important ways.

The primary contradiction came from Experiment III and IV, the results of which in conjunction with a consideration of the studies completed by Bower and Wishart (1977) and de Schöenen and Bower (pers comm) indicated that the infant had as much difficulty in coping with the spatial relation 'behind' as he did with the relations 'placed upon' and 'inside'. Bower and Wishart's study is particularly

important in this respect as it is the only reported study in which the infant's ability to cope with these relations was studied simultaneously and longitudinally. Their report that the understanding of these three relationships between objects developed synchronously strongly implies that the infant is faced with the same problem in dealing with each type of relationship. This finding questions the proposed explanation of the infant's difficulty with the relations "placed upon" and "inside" as the relation "behind" does not involve the sharing of object boundaries and spatial position. As was indicated in Chapter V, however, the spatial relation 'behind' could be incorporated within the proposed explanation of the infant's difficulty with the relations 'inside' and 'placed upon'. This incorporation was dependent upon the distance between the object and the screen being held as crucial in determining whether the two were seen as perceptibly separate from each other or as sharing a common boundary. The two studies which attempted to evaluate this hypothesis, Experiment VIII and that of de Schonen and Bower, found some tentative support for it, provided the infant's response in these studies to this variable was considered in conjunction with his limited motor skills, a point which will be returned to later.

On the one hand such a hypothesis may be considered a not too skilfully designed, last ditch attempt to maintain the original framework of this thesis. Certainly it is a hypothesis which warrents further investigation. There is a need to investigate the effect of distance of separation between object in screen in tracking studies which circumvent the problems posed by the limited motor skills of infants.

However this hypothesis gains theoretical support from a consideration of certain other findings of this thesis.

Firstly explanation of the infant's difficulty with the spatial relations 'in' 'on' and 'behind' in terms of the sharing of boundaries between objects would lead to the prediction that the type of objects entering into such relationships would affect the difficulty the infant had in dealing with them. A ball rather than a cube being placed on or behind another object would be predicted to provide the infant with less difficulty as the object boundaries of the ball and the screen or platform would be barely shared. In Chapter II this was reported to be the case with the relation 'placed upon'. Bower (1977) has in fact reported this to be the case for all the spatial relationships under consideration.

"At any age when spatial relationships are a problem, they (the infants) are far more likely to succeed with a ball than with a cube or a half ball for example."

(Bower: A Primer of Infant Development
(1977) P.117)

Secondly, with respect to the spatial relation behind, Bower, as was indicated in Chapter I, has provided a strong case that the infant's perceptual system innately transduces the optical information specifying X going behind Y and continuing to exist. This transduction he argues is a necessary prerequisite for the perception of three dimensional space. For this argument to be maintained in light of the reported difficulty the infant has with the relation 'behind', the distance of separation between X and Y has to be seen as crucial.

Thirdly given the studies by Bower and Paterson (1972), Wishart and

Bower (1977) and the results of Experiment 7, any explanation of the infant's difficulties in the Stage III-VI Object Concept tasks requires to relate this part of the developmental sequence to the accomplishments of Stages I-III. As indicated in the opening Chapter to this thesis none of the alternative theoretical frameworks for explaining the infant's difficulty in the former tasks do this. Explanation of the infant's difficulties in the Stage III-VI tasks in terms of the spatial relationships involved does. Within this explanatory framework the infant's definition of object identity must be related to featural as well as positional and movement information about the object (a Stage III accomplishment) before the infant can have a basis from which to resolve the problem posed by the sharing of object boundaries that is involved in the spatial relationships 'on' 'in' and 'behind' (the latter relation, of course, only being a problem under certain circumstances).

Fourthly, Experiments I and II, the studies reported in Chapter II by Piaget 1937 and Bower and Wishart (1976) and de Schöenen and Bower's study, all demonstrate that the infant experiences difficulty in the Stage III-VI Object Concept tasks irrespective of whether the object disappears from sight in such tasks. Stage IV-V errors are observed if the object is placed in full view on a platform, inside a transparent container or behind a transparent screen. Such results are congruent with the proffered thesis that the major difficulty facing the infant in the Stage III-VI tasks is that of understanding the spatial relationship between objects that pertain in these tasks. It is the nature of the transition 'in sight' to 'out of sight' that is crucial in the traditional Piagetian Stage III-VI tasks and not the disappearance of the object *per se*.

Thus while the evidence to date cannot be said to provide conclusive support for the proposed reinterpretation of what the development of the Object Concept is about and the derived explanation of the infant's difficulty with the Stage III-VI tasks in terms of the spatial relationships between objects that pertain in these tasks, the weight of the evidence would appear to favour this hypothesis over the traditional interpretation of this developmental sequence as being primarily about the infant's developing ability to conserve the existence of an object that is no longer visible.

This reinterpretation of the development of the Object Concept may be seen as splitting the developmental sequence into two distinct periods.

Period I (Stage I-III). Development of rules of object identity that incorporate featural positional and movement information about the object.

Period II (Stage III-VI). Development of rules of object identity that extend those of period I to incorporate relationships between objects that involve the sharing of object boundaries.

There however remain some problems with this proposal. The primary one is that during Period II of the developmental sequence the development of successful eye movement strategies to deal with the relations 'in' 'on' and 'behind' generally precedes successful manual search strategies (Mundy-Castle and Anglin 1969; Bower and Paterson 1973; Bower, Broughton and Moore 1971 and Bower and Wishart 1977). At first glance this finding of discontinuity or repetition in the

development of the infant's understanding of spatial relationships would appear to favour extending the spatial relationship explanation of the infant's difficulty in the traditional Stage III-VI reaching tasks to incorporate some of the features of Bressan and de Schonen's explanation of this difficulty, which pays greater attention to the type of response that is used to assess the infant's understanding. However the fact that practice in developing appropriate eye movement strategies can favourably affect the development of appropriate reaching strategies, Bower and Paterson (1972) sometimes to the extent that development of the latter appears instantaneous once the infant has the requisite motor capabilities, (Wishart and Bower 1977), argues against this discontinuity being explainable in terms of the response used to assess the infant's understanding. Rather it suggests that the discontinuity is to be explained in terms of the conceptual representation of the infant's understanding of the relationships.*

While practice in tracking tasks designed to test the infant's understanding of spatial relationships can and does improve performance in the reaching tasks, the relationship between the two is inverse. A little practice with the tracking tasks facilitates performance on manual search tasks a great deal more than does a lot of practice. The question is why.

* The assumption in this discussion is that had the infants in Wishart and Bower's study been given all the Stage III-VI reaching tasks they would have had no difficulty with any of the tasks. In reality the infants were only given the Stage III-V tasks.

Bower (1976) has proposed the following model to explain these results,

"The model we are using is based on data about short term perceptual development. Consider a simple experiment on habituation. If we show a baby a cube in a constant orientation ten times for 30 seconds each time, the baby will look at the cube progressively less and less. This indicates that the baby recognises that he is seeing the same object each time and is, naturally, less and less interested in it. Suppose we show the baby a cube ten times, in a different orientation each time. We get exactly the same decline in looking (Day & McKenzie 1973). Consider what this tells us about the way a baby remembers objects. The baby obviously cannot have a very specific image of a cube-in-a-orientation because every presentation is different in respect of orientation. He must remember that there is a cube out there, without remembering the orientation of the cube. This kind of memory is really rather abstract. It must be almost as abstract as a word is. It also lacks detail, even detail about something as important as orientation (see also Bower 1966). Nonetheless given time a baby can work up a very specific internal description of an object so that even very slight changes will arrest the decline in looking behaviour. In short term perceptual learning the baby's internal description of an object thus goes from rather abstract to very specific.

We would like to propose a similar kind of process in conceptual development, with the baby or infant progressively elaborating his description of events to make them more specific, thereby changing the likelihood of smooth transfer from one skill to another, and thereby increasing the likelihood of a seeming repetition." (CONCEPTS OF DEVELOPMENT, BOWER 1976)⁸

As applied to the problem of the development of the Object Concept this latter statement implies that in a tracking task in which an object moves 'behind' 'in' 'on' another object the infant first of all learns to co-ordinate his place and movement rules of object identity, to use featural information in defining the identity of an object. Once the infant recognises that the object which 'disappears' 'behind'

'onto' 'in' the screen, platform, tunnel is the same as that which reappears on the other side of the track he has to work out what has happened to it when it 'disappears' i.e. development an understanding of the relations 'in' 'on' and 'behind', realise that two objects may share common boundaries without losing their individual identity. This understanding need not generate particularly accurate tracking as the infant has not yet articulated the precise spatio-temporal parameters of the task in hand. It will, however, enable him to transfer this understanding to the reaching tasks given the common principle on which both tasks are based. If however the infant is given increasing practice in the tracking tasks his tracking will improve in so far as he will work out specific sensori-motor rules that articulate the particular spatio-temporal nature of the tracking task such as

"to see the object which has vanished on the left hand side of the tunnel, look for it at the right hand side after X seconds" (from Bower 1976).^e

Such increased specification of his understanding of the tracking tasks inhibits transfer of learning from these tasks to the reaching tasks. A rule of the above type is clearly not applicable to the reaching task and thus the infant when faced with the reaching tasks appears to have to relearn an understanding of the relations 'in' 'on' and 'behind'. He has to dredge the general principle that two objects can be in the same place at the same time from his memory in order to successfully cope with the reaching tasks. The fact that the infant can, given appropriate environmental input, generalise his understanding of the relations 'in' 'on' and 'behind' from a tracking task to a reaching task has important implications for alternative theories of

the nature of the problem facing the infant in these latter tasks.

Bresson and de Schonen's explanation of the infant's difficulty in the latter tasks is a purely perceptuo-motor one. It cannot possibly account for such perfect transfer of competence from a tracking task to the reaching tasks.

Butterworth's (1975)⁸ explanation of the infant's difficulty in the reaching tasks in terms of conflict between egocentric and relative codings of object position is centred on the fact that in the traditional Stage IV-V reaching task the object is displaced relative to two other objects in the visual field. However in the tracking tasks the object is displaced relative to only one other object yet the infant's understanding of this situation is sufficient to enable him to cope perfectly with the Stage IV-V reaching task. Such transfer of understanding suggests that the problem facing the infant in the latter task is not specific to two 'occluders' being present in the infant's visual field. A similar criticism applies to Pascual-Leone's model of the Object Concept.

However unless given the appropriate environmental input the infant would appear to have to relearn in the Stage III-VI reaching tasks that objects continue to exist as independent entities even when they share spatial boundaries. In Chapter I it was argued that the initial stage in this development was when the infant became aware of the conflict between his initial reaction to the sharing of object boundaries - namely that the object had been suddenly and mysteriously replaced by another object - and his recognition that the object which reappeared when he hit the platform, screen, cup was the same as that which had

been mysteriously annihilated. The infant was thus seen to enter the Stage IV-V reaching task with a magical understanding of the relationship between his action on the platform, screen, cup and the reappearance of the object. This magical understanding was argued to take the form of a contingent rule of the type. "Contact replacement object to retrieve original object." The problem facing the infant in the Stage IV-V task was argued to be the fact that two objects competed for the title of replacement object. In Chapter I it was argued that choice between the replacement objects was based on their respective positions. It however is equally possible to argue that the infant's choice between the set of two possible replacement objects is determined by response perseveration. As such, it should be obvious that the restatement of what the problem is to the infant, in the later stages of the development of the Object Concept does not in any way resolve the controversy, described in Chapter I, about the strategies used by the infant in attempting to solve the Stage IV-V reaching tasks. These strategies however are seen to derive from a lack of understanding of the spatial relationships between objects and not from a lack of understanding that objects continue to exist when no longer visible. Further comparison of the type of strategies employed by the infant in tracking as opposed to reaching studies of his understanding of the relations 'in' 'on' and 'behind' might provide information about how motor skill limitations constrain the type of strategy employed.

This explanation of the relationship between successful eye tracking strategies and reaching strategies in development through period II of the Object Concept also has implications for how this development is conceptualised. Bower's model suggests that development

of understanding of a given event proceeds from a rather abstract conceptual form to a more specific description that is closely related to the type of responses being used to assess understanding. While this proposal is congruent with the assumptions underlying the proposed reinterpretation of the development of the Object Concept, it is in direct contradiction to Piaget's classical description of the processes underlying the development of the Object Concept. This latter description sees the infant's understanding of objects as being an integral, and not separate, feature of the type of actions he brings to bear on objects. Only through progressive differentiation of such action schemas does the infant come to form a more abstract and therefore more conceptual understanding of objects. Wishart and Bower's study, reported in Chapter V, would appear to favour Bower's model of the process of conceptual development over the Piagetian one. More studies on the relationship between training tasks and generalisation from these tasks to other tasks is required before the evidence can be said to be conclusive one way or another.

Finally if development through the latter stages of the Object Concept is development of the infant's understanding of the spatial relationships that exist between objects, what factors are important in it?

With respect to the traditional Stage III-VI reaching tasks it is obvious that if the infant's understanding of the relations 'in' 'on' and 'behind' are to be tested in this format, a certain degree of motor skill is required. As was indicated in Experiment 8 and in the de Schöenen and Bower's study motor skill limitations differentially affect the degree of difficulty the infant has with the relations in front of

and behind even if the conceptual problem of each relation is identical. Reaching round an obstacle and removing an obstacle for another present motor skill difficulties to the infant (Bruner 1968). The motor skill requirements of the Stage III-V transition tests with platforms are less than those for such tasks with screens or cups or cloths. Such a difference may contribute to the fact that the relation 'placed upon' appears an 'easier' relation for the infant to understand in that test context while there is no difference in the 'ease' with which the infant develops an understanding of these three relations in tracking studies where the "motor requirements" for demonstrating understanding of each relation are equal (Wishart and Bower). With respect to these five month old infants who directly transferred their understanding of this set of spatial relations from a tracking to a reaching task one can only presume that their conceptual understanding of the task in hand was such that it freed their processing capacities to concentrate solely on the appropriate motor action plans for the task in hand.

However it must also be noted in this discussion of motor skill and the development of the Object Concept that reaching experiences of themselves are not essential for the development of an understanding of spatial relationships as Wishart and Bower's study and Gouin Decarie's (1965) study of the development of the Object Concept in thalidamide children clearly indicate.

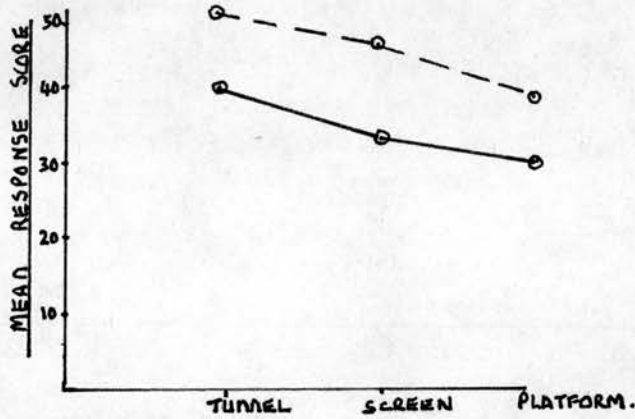
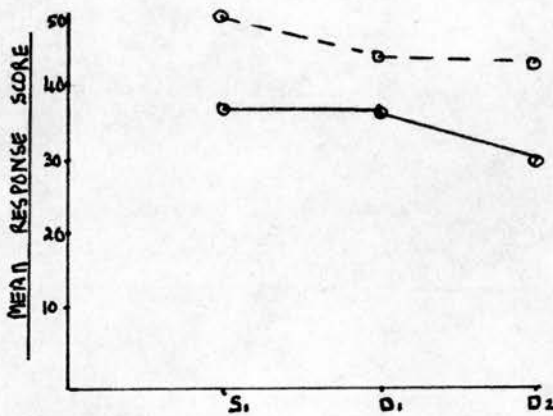
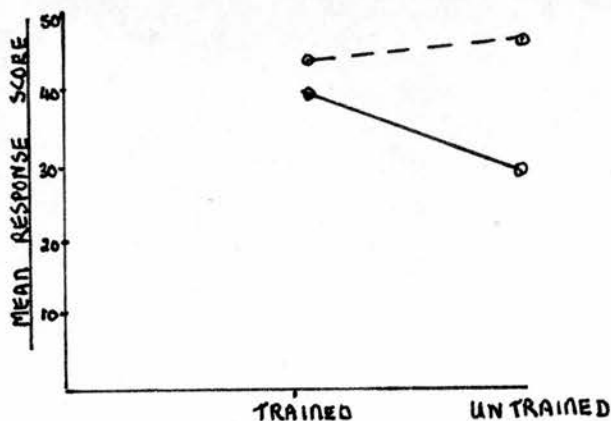
Understanding of the relations 'in' 'on' and 'behind' does not appear to be capable of being developed from the simple read-off of perceptual information, for as Experiment I demonstrated extensive practice with objects "hidden" inside transparent containers did not

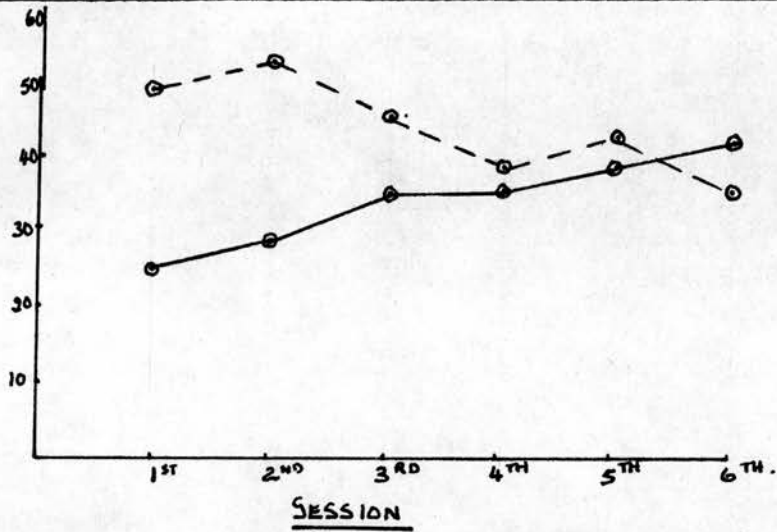
lead to an understanding of the relation inside but rather to the formation of a contingent rule that was sufficient for success in the Stage III-V task with transparent containers but failed to generalise, as understanding of the principle involved in the task would have done, to testing involving an object hidden inside an opaque container. Certainly, however, perceptual development in itself would appear to be an important factor in the understanding of these relationships. Increase in the processing capacity of the infant's perceptual system would appear to be a necessary condition for the infant to be able to analyse featural information about an object. The use of featural information is seen as an essential step in the co-ordination of the infant's place and movement rules of object identity. Likewise increase in the infant's memory capacity allows for greater description of the characteristics of an object. On the other hand, the limitations of the infant's perceptual system are seen to be related to the degree of difficulty the infant has in dealing with the spatial relation 'behind'.

The fact that the infant's understanding of the spatial relations 'in' 'on' and 'behind' cannot be read off from perceptual input favours a constructivist model of the nature of conceptual development. It suggests that development of an understanding of the relations 'in' 'on' and 'behind' comes from conflict between two alternative modes of comprehension of a given event. The suggestion in Chapter I, a suggestion maintained through this thesis, is that the initial propelling conflict for getting the infant off the ground in the later Stages of the Object Concept is conflict between his initial reaction to an object sharing its boundaries with another object namely that the

object has been annihilated and his reaction to the reappearance of the object, namely that it still exists.

In conclusion then, while this thesis cannot be said to provide conclusive evidence for the proposal that development through the later stages of the Object Concept is development of the infant's understanding of spatial relationships between objects that involve the sharing of object boundaries, it is argued that this proposal, to date provides the most comprehensive picture of what the development of the Object Concept is about.

Appendix .DATA from EXPERIMENT VIITHE EFFECT OF CONDITION ON ATTENTION AND ANTICIPATIONTHE EFFECT OF S_1 D_1 D_2 ON ATTENTION AND ANTICIPATIONTHE EFFECT OF TRAINING ON ATTENTION AND ANTICIPATION

THE EFFECT OF SESSION ON ATTENTION AND ANTICIPATION

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